



Naval Command, Control  
and Ocean Surveillance Center  
RDT&E Division

San Diego, CA 92152-5001

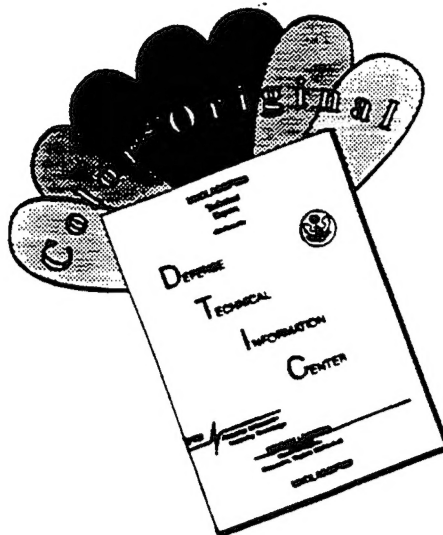


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# Naval Command, Control and Ocean Surveillance Center RDT&E Division

San Diego, California 92152-5001

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## FOREWORD

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We live in a world that has changed significantly in a short time. Political and economic changes will continue to shift many resources from defense to other areas. To meet the military requirements of the future while remaining competitive in today's market requires a new approach to how the Navy does business. Of primary interest will be the design of systems that are compatible and interoperable. Top-level requirements have been defined and architectural options have been initiated to ensure that individual systems will provide an integrated capability in support of joint, theater, force, and unit levels. To facilitate this integration, on 2 January 1992, the Navy established the Naval Command, Control and Ocean Surveillance Center (NCCOSC) as one of four major warfare centers. NRaD is the RDT&E Division of the NCCOSC command. Early in 1996, NCCOSC's West Coast In-Service Engineering Division (NISE West) merged with NRaD, adding direct fleet support and in-service engineering to the full-spectrum of capabilities we offer our customers.

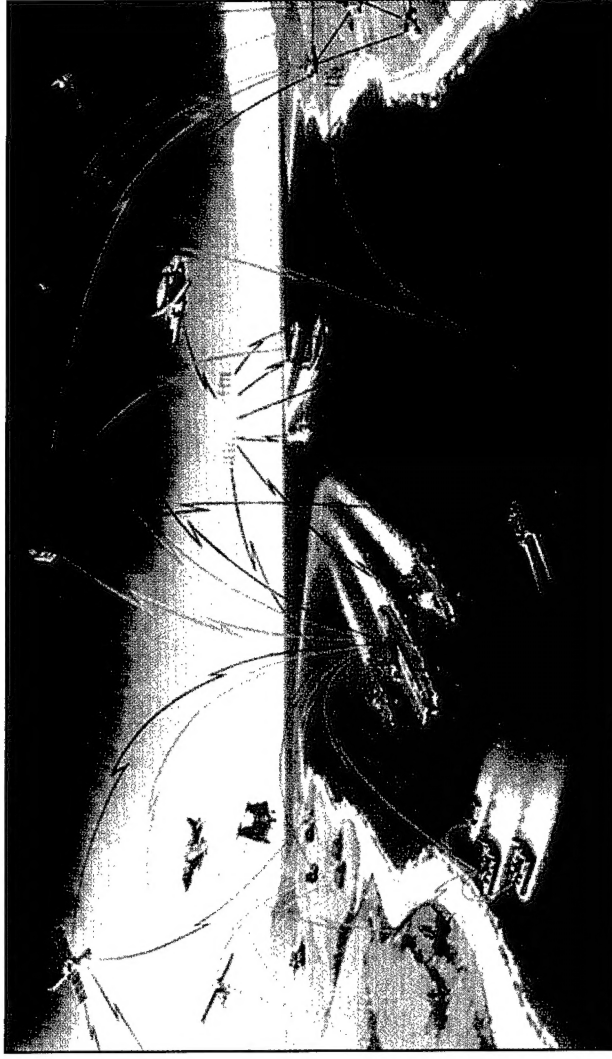
## NCCOSC RDT&E DIVISION (NRaD)

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### MISSION

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To be the Navy's research, development, test and evaluation, engineering and fleet support center for command, control and communication systems and ocean surveillance and the integration of those systems which overarch multiplatforms.



### LEADERSHIP AREAS

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- Command, control, and communications systems
- Command, control, and communications systems countermeasures
- Ocean surveillance systems
- Command, control, and communication modeling and analysis
- Ocean engineering
- Navigation systems and techniques
- Marine mammals
- Integration of space communication and surveillance systems



# INTRODUCTION TO NRaD

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The Naval Command, Control and Ocean Surveillance Center (NCCOSC) RDT&E Division (or NRaD) is a full-spectrum RDT&E laboratory serving the Navy, Marine Corps, and other Department of Defense and national sponsors within its mission, leadership assignments, and prescribed functions. NCCOSC is one of the Navy's four major warfare centers and reports directly to the Commander, Space and Naval Warfare Systems Command (SPAWAR) in Washington, DC. At NRaD, we provide solutions to Navy, joint service, and national problems by generating and applying science and technology. We provide innovative alternatives to tomorrow's decision makers, enabling them to pursue new or expanded missions and capabilities.

NRaD's recent merger with NISE West enhances our ability to provide fleet, joint, and national users and customers with complete life-cycle support. This support spans efforts that range from generating science and applying technology to creating new system concepts and upgrading older systems to perform previously unforeseen roles. We also work with SPAWAR, other Navy system commands, the Office of the Chief of Naval Operations, the Fleet, the Office of Naval Research, defense and national agencies, academia, and industry to produce quality products and services. Our roles include providing leadership for developing systems and solutions and functioning as a "smart buyer" to ensure that the government purchases quality products in an increasingly complex and technological marketplace.

At NRaD, we are strongly committed to our customers. We maintain close contact with them to ensure that our efforts remain relevant and meet the needs and threats of tomorrow; our goal is to ensure that Navy, joint commands, and defense and national agencies—the ultimate users and customers of our products—retain technological and operational superiority. We are also uniquely capable of serving operational users during national crises. Specifically, we support systems that we have helped introduce into today's forces by providing technical expertise and laboratory and test facilities as well as on-site assistance not available to operational commands.

We continue to serve our sponsors in roles for which we have demonstrated expertise: creation and demonstration of technology, program formulation and initiation, Technical Direction Agent, Acquisition Executive Agent, Software Support Agent, system and subsystem prototyping, in-service engineering, and the support of test and evaluation. We also actively license technology and support the transition of technology to industry.

## INTRODUCTION to NRaD

NRaD receives funding from sponsors that include SPAWAR, the Naval Sea Systems Command (NAVSEA), the Naval Air Systems Command (NAVAIR), the Office of Naval Research (ONR), and the Defense Advanced Research Projects Agency (DARPA).

NRaD has six major technical departments: Navigation and Applied Sciences; Command and Control; Fleet Engineering; Surveillance; Communications; and NRaD Activity, Pacific.

The following sections of the Brief describe NRaD facilities and resources, programs, and accomplishments. This Brief presents Fiscal Year 1995 accomplishments. Funding, organizational, and personnel information may be found in later sections. An acronym and abbreviation list is provided at the end of the Brief for reference.

## FACILITIES AND RESOURCES

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### INTRODUCTION

NRaD has superb facilities for conducting RDT&E and life-cycle support functions in command, control, communications, computers, intelligence, surveillance, and reconnaissance (C<sup>4</sup>ISR). NRaD's laboratories offer worldwide networking capabilities plus the ability to participate in major joint exercises. NRaD also has the waterfront access and berthing capabilities vital to its activities in ocean surveillance, ocean engineering, and marine sciences.

Extensive in-service engineering facilities provide a full range of system engineering, management, logistics, installation, and technical support. The mobile tactical systems shelter production area and system integration laboratories are located at the Old Town campus in San Diego. The production area provides a large open-bay facility for maneuvering mobile shelters and is equipped with large roll-away access doors that permit tractor-trailer access through the building.

Facilities in Hawaii, Japan, and Guam provide fleet support to our customers in the mid and Western Pacific. The NRaD detachment in Warminster, PA, provides facilities for navigation and airborne communication systems. The detachment will relocate in October 1996.



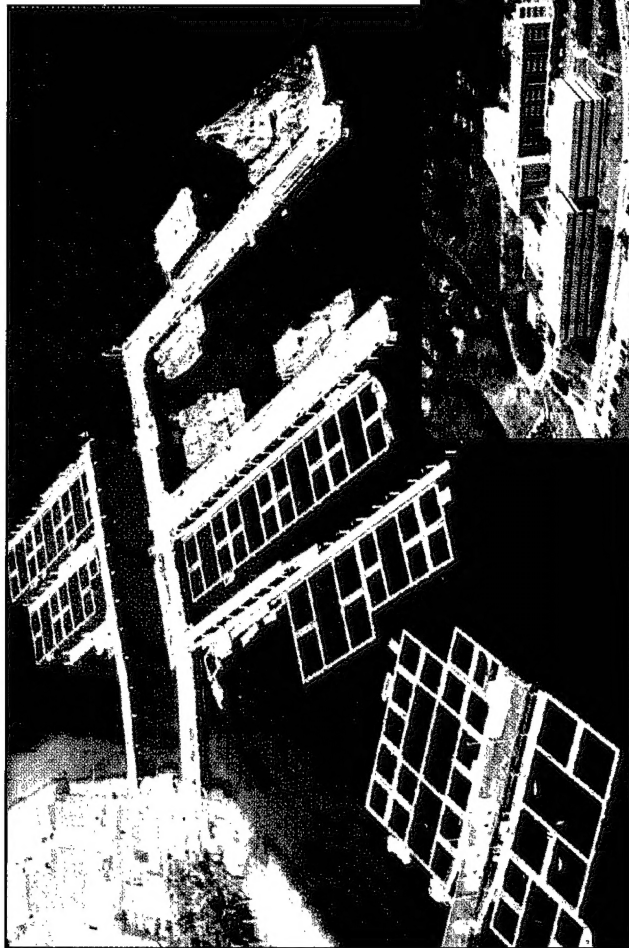
*Point Loma Complex.*

## FACILITIES AND RESOURCES

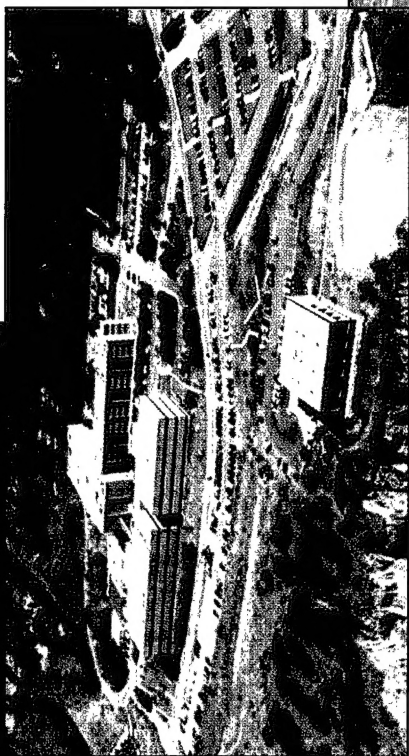
In San Diego, NRaD occupies more than 580 acres. Facilities are concentrated in four major areas: Topside, Bayside, Seaside, and Old Town. NRaD Topside, located on the ridge of Point Loma, includes the principal administrative and support sections, as well as facilities for communications, environmental testing, electronic materials, advanced electronics, laser technology, and ocean surveillance. NRaD Bayside faces San Diego Bay, which provides waterfront access and berthing capabilities. NRaD Seaside, located on the west slope of Point Loma, offers a protected, electromagnetically shielded site essential to RDT&E in C<sup>3</sup>I and ocean surveillance. Old Town Campus provides in-service engineering facilities, production capabilities, and laboratory testing for fleet connectivity.



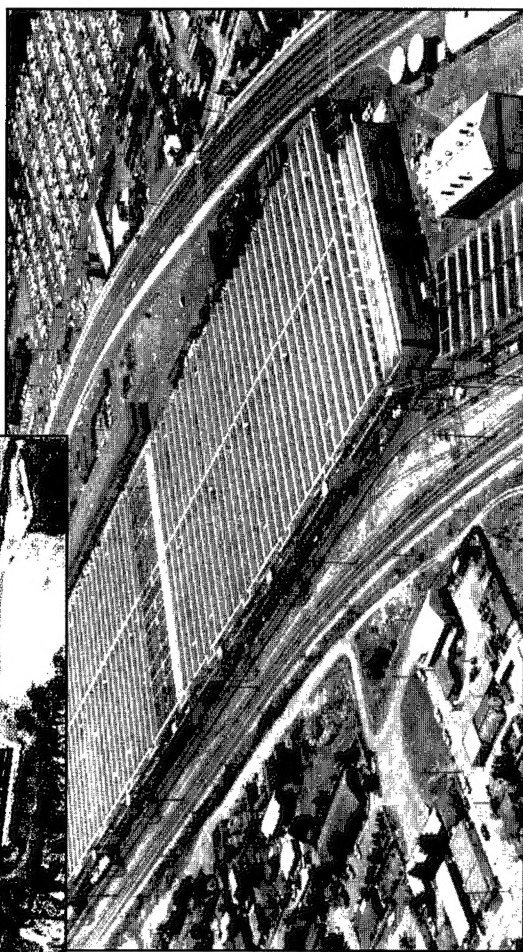
*Building 33 and surrounding area, Topside.*



*Berthing Pier 160 and marine mammal cages, Bayside.*



*Building 600, Seaside.*



*Old Town Campus.*

## Distributed Test Beds

C<sup>4</sup>ISR systems must link ship, aircraft, submarine, land, and theater, joint, allied, and coalition forces into an information network that supports the warriors in the execution of their assigned mission. The overarching nature of these systems requires test beds that support the integrated testing of multiple configurations that involve components on a global scale. Connectivity for these distributed test beds is provided by Integrated Virtual Networks using both military and commercial communications systems. Distributed test beds facilitating system development, integration, and evolution include Link-16, SATCOM, Tactical Receive Equipment/TRE-related Applications (TRE/TRAP), Global Access Lab, and the Submarine Communications Integrated Test Facility.

From modeling and simulation to fleet exercises, at-sea testing, and global exercises, NRaD continues to develop integrated test beds for multipatform systems. NRaD has put in place the communications connectivity to allow most of the Navy's C<sup>4</sup>ISR systems to be interconnected to support developmental testing as well as to participate in live operations with fleet units.

## High-Performance Computing

NRaD is a leader in DoD high-performance computing (HPC). Recent additions to this capability are the Convex Exemplar and Intel Paragon computers. These machines provide scalable parallel computing to address the next generation of computationally intensive DoD applications. Command-wide facility connectivity at optical and Synchronous Optical Network (SONET) data rates is provided to enhance and enable global connectivity for state-of-the-art advances in HPC, networking, and information integration.

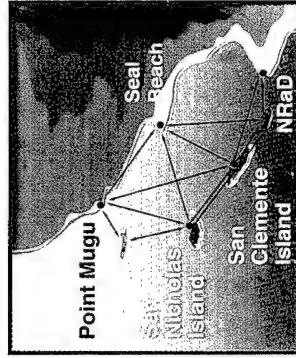
## Information Transfer Management Structure

The enabling part of NRaD's total capability is the Information Transfer Management Structure developed by the Communications Department to provide for and manage rapid reconfiguration of our significant C<sup>4</sup>ISR capabilities and to provide national and international connectivity using commercial and military capabilities in support of primary mission areas.

## Surveillance

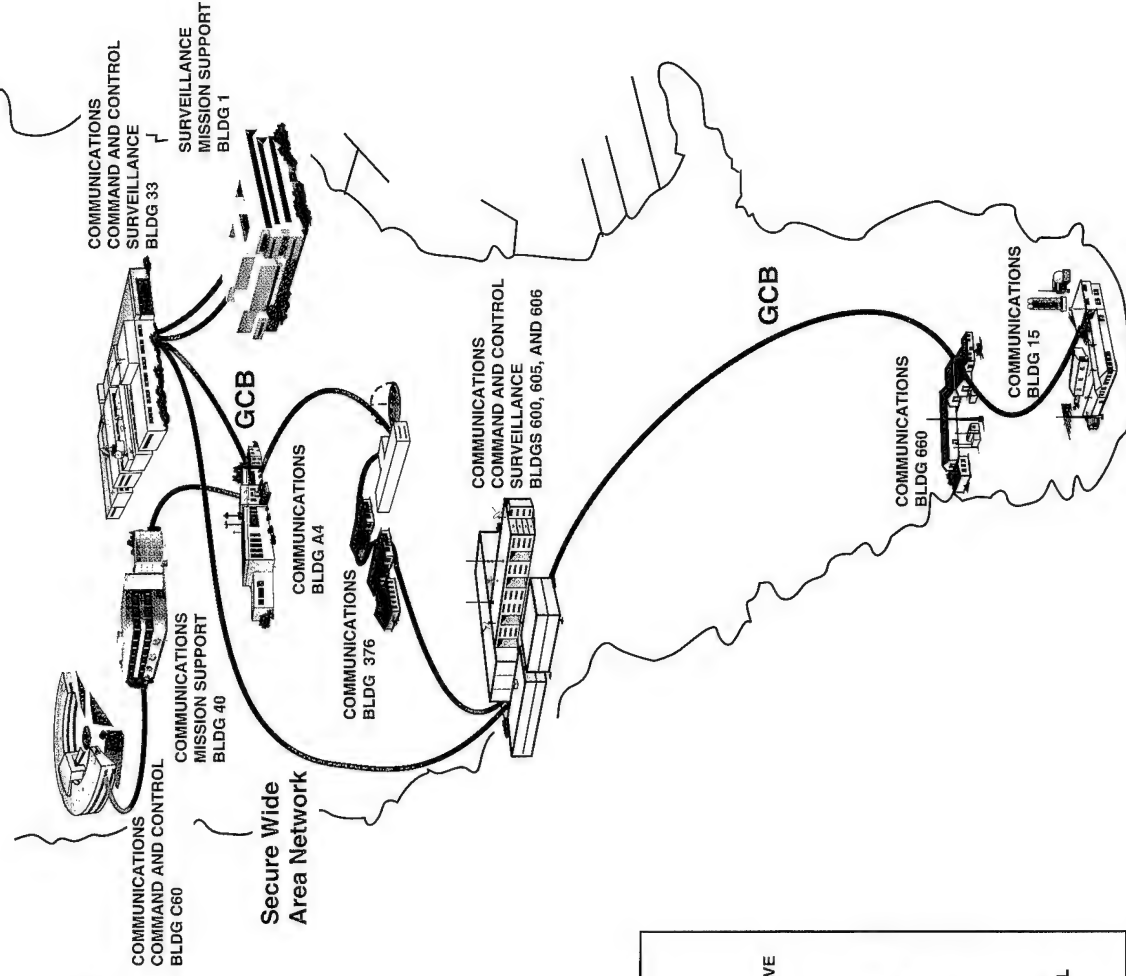
NRaD's surveillance resources include field sites for electromagnetic, electro-optic, and acoustic experimentation off Point Loma and nearby locations, and in-house facilities such as the Tactical Surveillance Laboratory, the Surveillance Test and Integration Center, and the Parallel Processing Applications Laboratory. Access to operational data links combined with a close working relationship with air, surface, and submarine units provide a complete systems analysis, engineering, integration, and test capability.

# Major C<sup>4</sup>I and Ocean Surveillance Facilities



## CONNECTIVITIES TO OPERATIONAL USERS (partial listing)

OTCIXS	UHF LOS
TADIXS A	SHF LOS
TADIXS B	COMMERCIAL MICROWAVE
SSIXS	STREAMLINER
TACINTEL	MUSIC
NAVMACS	SCCS
FBCST	UHF SATCOM
LDMX	SHF SATCOM
TADIL J/LINK 16	EHF SATCOM
TADIL A/LINK 11	COMMERCIAL SATCOM
TADIL C/LINK 4A	AT KU AND C BAND
TADIL B	NATIONAL NETWORKS
TRAP/TRE	JDL NET
DODIIF	DREN
DISNET	NSF NET
MILNET	DSI NET
ITN	NCI NET
HF ELOS/LOS	HIGH RATE COMMERCIAL
VHF LOS	LANDLINES T1, T3, OC (PROPOSED)



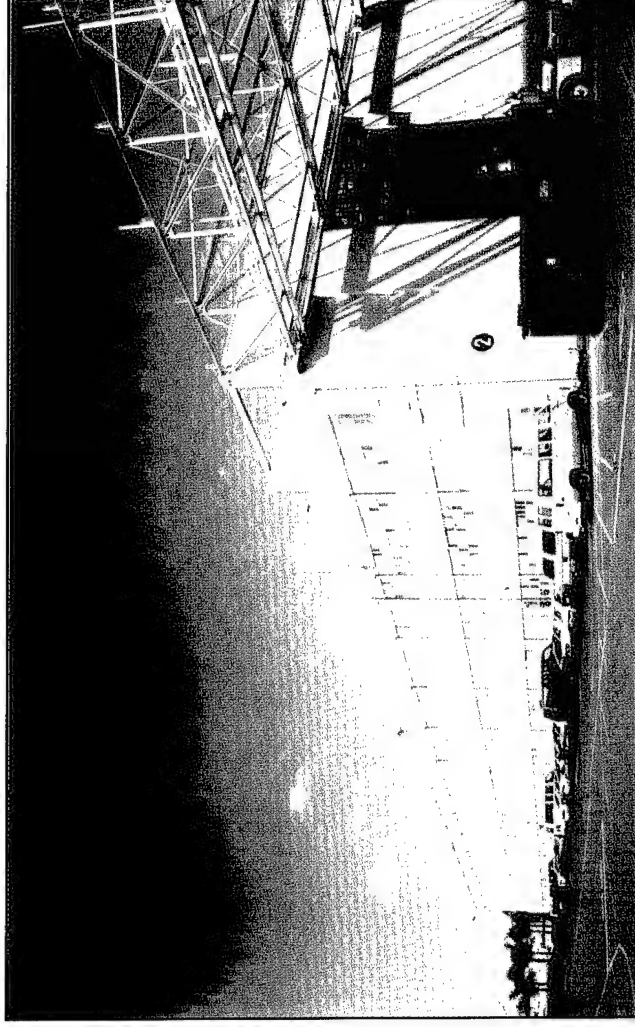
Major C<sup>4</sup>I and Ocean Surveillance Facilities.



## Fleet Support and In-Service Engineering

### FACILITIES AND RESOURCES

A 1.6-million square-foot industrial complex at Old Town (formerly NISE West) offers a wide range of fleet support and in-service engineering facilities in San Diego, including integrated/configurable test facilities and laboratories, an SCI facility with shielded enclosures, classified/unclassified data/tape libraries, equipment/system restoration assembly/production areas, warehouse/storage areas, and railway access.



*Building 2, Old Town Campus.*

The NRaD Activity, Pacific, provides fleet support facilities in the mid and western Pacific Ocean.

## Navigation

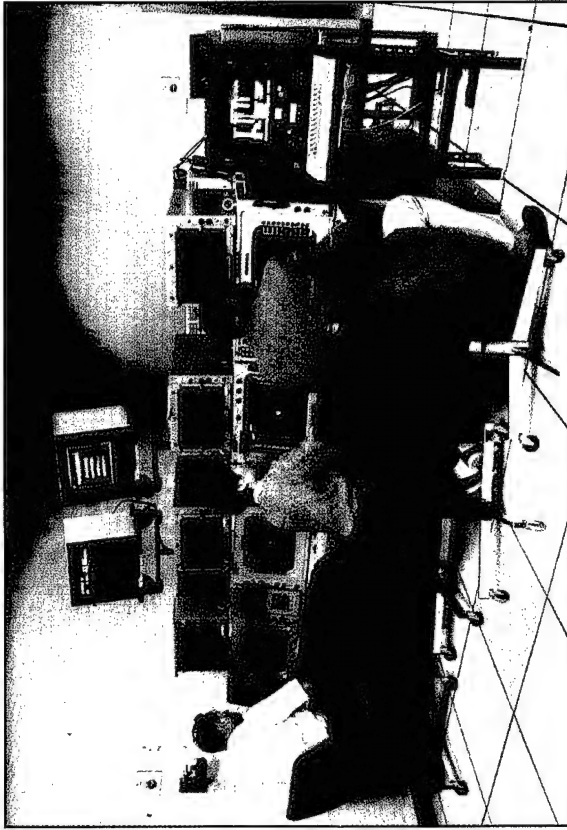
NRaD Detachment, Warminster, is located at the Naval Air Warfare Center, Aircraft Division, Warminster, PA. As a full-spectrum Navy laboratory, it provides engineering services to DoD for developing military navigation and airborne communications systems. The Inertial Navigation Facility, located in Warminster, provides a uniquely quiet environment that isolates noise and vibration, allowing extremely high stability and long-term inertial sensor measurements. The detachment will relocate to San Diego in October 1996.



## COMMAND AND CONTROL (C<sup>2</sup>)

**Combat Direction System (CDS) Development and Evaluation Site (CDES)**, a secure facility for development of the Advanced Combat Direction System (ACDS) Block 0, ACDS Block 1, and Command and Control Processor (C<sup>2</sup>P).

**Display Technology Laboratory** that supports development and application of new technologies to C<sup>2</sup> systems.



*Combat Direction System (CDS) Development and Evaluation Site (CDES).*

**Distributed Command and Control (C<sup>2</sup>) Laboratory** that provides hardware, software, and communications connectivity to support the development and application of distributed processing technology to C<sup>2</sup> systems.

**E-2C Airborne Tactical Data System Integration Laboratory** for software support of the three fleet baselines and foreign military sales (FMS).

1996



*E2C Airborne Tactical Data System (ATDS) Integration.*

**High-Performance Computing Laboratory** that provides a wide range of advanced computer systems for the scientific investigation of next-generation architectures.

**Intelligence System Advanced Development Laboratory** with RFI-shielded, vault-level security and capability to receive and process data from various sources through online communications.

**Navy Command and Control System-Ashore (NCCS-A) Integration and Test Facility** that provides hardware, software, and communications for full operational testing of command systems.

**Navy Tactical Command System-Afloat (NTCS-A) Test Bed and Integration Facility** that provides a mockup of a CV installation to support development, integration, and interoperability testing.

**Ocean Surveillance Information System (OSIS) Evolutionary Development (OED) Laboratory** that provides hardware, software, and communications connectivity for development of replacement systems and full integration testing.

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tion control systems, including analysis of fleet protocol definition, operator interfaces, and system engineering.

**Commercial SATCOM Facility** for buying, integrating, and testing commercial and nondevelopmental items.

**EHF SATCOM Terminal Test Facility** that provides a basis for ship, submarine, and shore site terminal development and follow-on support in MILSTAR EHF systems.

**Environmental Test Facility** for performing mechanical shock, vibration, climatic condition, and EMI/RFI tests.

**High-Data-Rate Mobile Internet (MONET)**, a test bed for high-data-rate tactical communication technologies. MONET will incorporate new applications using commercial standards such as Asynchronous Transfer Mode (ATM) and the Synchronous Optical Network (SONET) high-data-rate military radios, and DoD and commercial satellite communication (SATCOM) links.

**Information Transfer Management Structure (ITMS)** that provides integrated management of the automated, distributed, fiber-optics-connected information transfer system and management of the connectivity between all major C<sup>4</sup>I and ocean surveillance facilities at NRaD.

**Integrated Interior Communications and Control System**, a networked environment with hardware, software, test equipment, and network management capability to support total ship interior communications development.

**Joint Maritime Communications Strategy (JMCOMS) Simulation Facility** that provides an environment for evaluating software components being developed for communication control systems; analysis includes fleet protocol definition, operator interfaces, and system engineering.

**Manufacturing Facility** for prototype development that is connected to the local-area network for remote transmission of digital manufacturing data.



*Navy Tactical Command System-Afloat (NTCS-A).*

**OTH-T Reconfigurable Land-Based Test Site (RLBTS)**, a secure interoperability test laboratory to support Navy and joint Over-the-Horizon Targeting (OTH-T) interoperability testing.

**Range Naval Tactical Data System Integration Laboratory**, including UYK-43 computer with UYQ-32 console emulators and peripherals.

**Systems Integration Facility (SIF)** for testing and integrating Navy Joint Tactical Information Distribution System (JTIDS) terminals with aircraft data systems and shipboard combat direction systems, and for testing the interoperability of Link-16 systems.

## COMMUNICATIONS

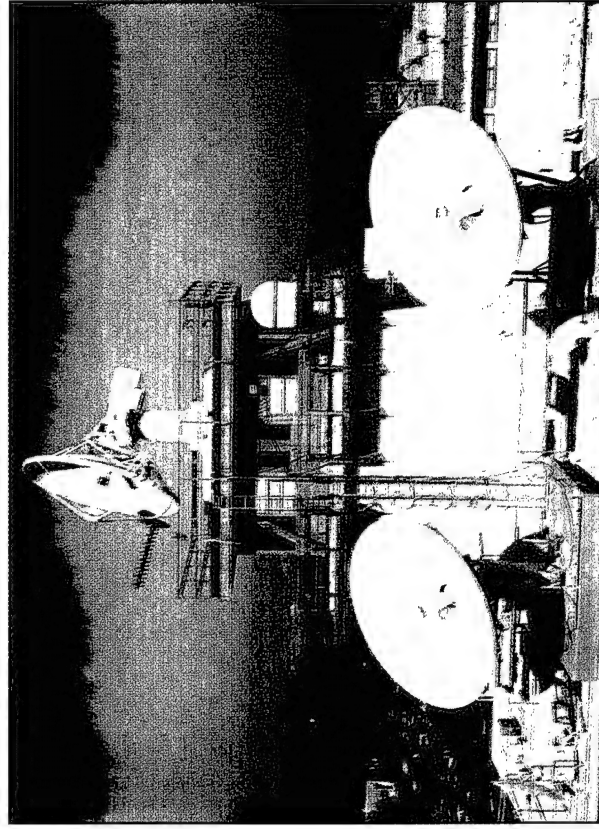
**Advanced Digital Network System (ADNS) Simulation Facility**, for evaluation of hardware and software under development for communica-

**Modeling and Simulation Operation Support Cell (MOSC) Prototype** that provides help to the warfighter with modeling and simulation requirements and provides collaborative insight into the joint planning process.

**Navy UHF Satellite Communications Test Facility (NUSTF)** that provides information exchange subsystem development and testing, direct support to fleet exercises, determination of new requirements, and development of system improvements.

**Secure Facilities, Vaults, and Underground Bunkers** for development, testing, and operation of communication systems that use highly classified data.

**SHF SATCOM Test Facility** that contains a complete SHF SATCOM terminal and test equipment to support follow-on SHF equipment development.



*SHF SATCOM Facility.*

**Ship Antenna Model Range** for simulation and modeling of ship communications, consisting of ground planes, model ships, track, towers, control systems, test equipment, data collection systems, data-reduction computers, and analysis software and components.



*Model Range Arch.*

**Ship Antenna Simulation Facility** that operates with the ship antenna model range to provide software modeling and simulation of systems, confirmation of models, and extensions beyond the test capability of the model range.

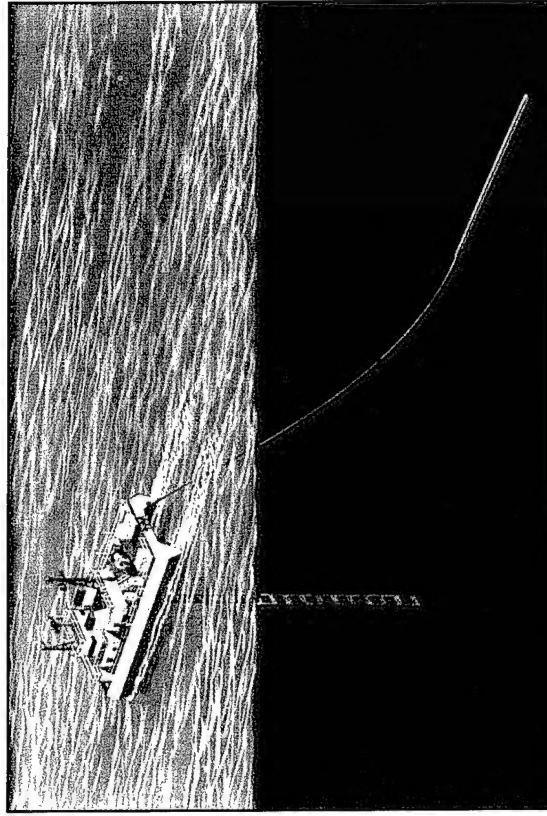
**Ship Motion Simulator Facility** for testing motion-compensated antennas, optics, etc., in various simulated sea states.

**Southern California Communications Networking Test Range** that maintains and controls sites at Pt. Mugu, San Nicolas Island, San Clemente Island, Seal Beach, and NRD, SD, for use in multiforce communications testing and support of West Coast fleet exercises.

**Structural Materials Sciences Laboratory** for investigation and analysis of metals, composite, corrosion, and failure effects.

**Submarine Communications Integrated Test Facility** that includes a full-capability VLF/LF RDT&E laboratory, simulated terminals, a submarine radio room, RF equipment, control devices, software evaluation, test equipment, and analysis tools.

## **SURVEILLANCE**



*Undersea Surveillance.*

**Cryptologic Systems Land-Based Test Facility (LBTf)** that supports the prototyping, integration, validation, and testing of tactical cryptologic and information warfare exploitation systems.

**HF Propagation Software Integration and Application Laboratory** that provides an RDT&E facility for multiuser hardware/software development.

**Joint Space and Tactical Systems Division RF Laboratory**, a test facility with state-of-the-art RF test equipment, a 100-dB shielded enclosure, and UHF and SHF satellite terminal facilities.

**Microwave and Millimeter-Wave Antenna Range Complex** that supports development of surveillance antennas for numerous operational applications.

**PDEC Application Library for C++ (PAL++)**. An easy-to-use software toolkit, free to U.S. Government users, that is designed to significantly reduce cost and time-to-market for critical DoD applications. Features include modern user interface building, data format and management, Sybase and Oracle access, DMA map products, and built-in, context-sensitive help.

**Processing and Data Exploitation Center (PDEC)**, an in-house laboratory facility to conduct data fusion and information processing research for the exploitation of national systems products for National, Unified, and Specified Command, and joint service and tactical applications.

**Real-Time Embedded High-Performance Computing Facility (RTEHPCF)**, established with the support of the DoD High-Performance Computing Modernization Office, that provides highly parallel computing resources in a secure environment with encrypted external network access for state-of-the-art applications of parallel computing and visualization to naval and DoD problems and systems.

**Signals Warfare Integrated Facilities Test Bed (SWIFT)**, a secure EMI/EFI facility that supports the full spectrum of analysis, system development, test and evaluation, simulation, and integration in a multi-system environment supporting signals intelligence (SIGINT), countercommunications, signal security (SIGSEC), information warfare, and related cryptologic systems.

**Surveillance Radar Development Facility** that provides a test bed for development of radar waveforms, techniques, and equipment to support inverse synthetic aperture radar (ISAR), radar cross section (RCS) measurements, and higher resolution radar developments.

**Surveillance Test and Integration Center (STIC)**, an RFI-shielded vault that can receive and process data from various sources through online communications. STIC supports the Integrated Undersea

## ELECTRONIC SCIENCES AND TECHNOLOGY

**Electronic Materials Sciences Laboratory** with facilities for research in non-silicon semiconductor materials, devices, circuits, and optoelectronic applications.

**Integrated Circuit (IC) Design, Fabrication, and Packaging Laboratory** with facilities for research on silicon materials, IC processing technologies, and circuit prototyping.

**Materials Research Laboratory** for experimental investigations of high-technology materials such as high-temperature superconductors and conducting polymers.

**Specialized Systems** support for high-interest problem areas and scientific, general-purpose, and business applications on a diverse suite of computer systems, including parallel and vector supercomputers and visualization workstations.

## MARINE SCIENCES

**Bioscience Facility** for acoustical physiological research, training, and handling of marine animals to perform naval tasks in the open ocean.

**Ocean Sciences Laboratory** with special facilities for work in marine biology and toxicology, environmental chemistry research, analytical instrumentation development, marine environmental quality assessment and monitoring, environmental biotechnology, radiation sensor development, lasers, and microelectronics.



*Radar Cross Section (RCS) Calibration Tower at Field House 33.*

Surveillance System (IUSS) (including Surveillance Towed-Array Sensor System (SURTASS) and Sound Surveillance System (SOSUS)); Relocatable Over-the-Horizon Radar (ROTHR); Fixed Distributed System (FDS); Surveillance Direction System (SDS); Battle Group Passive Horizon Extension System (BGPHERS); Intelligence, Surveillance, and Reconnaissance (ISR) (an over-arching collection of sensor, processing, fusion, display, and dissemination systems); and other tactical or communication efforts that support joint warfare efforts and the C<sup>4</sup>ISR warrior. STIC provides a test bed for the support of software development, integration, developmental verification and validation testing, life-cycle support, data acquisition, and real-time signal processing and display.

**Tactical Engineering Analysis Laboratory (TEAL)**, an in-house laboratory facility that provides computers and communications for the analysis and development of classified tasks.

**Tactical Surveillance Laboratory (TSL)**, a centralized facility for multiservice and national organizations to display and analyze tactical data systems.





*Dolphin with Trainer.*

## DESIGN ENGINEERING, TESTING, AND PROTOTYPE DEVELOPMENT

**Transducer Evaluation Center (TRANSDEC)**, a sonar transducer calibration pool that is anechoic at all frequencies.

**USS *Dolphin* (AGSS 555)**, a unit of Submarine Development Group One, used for research and development of advanced sonar equipment and systems.

## COMPUTER SUPPORT

**Corporate Communications Systems** support for internal communications, networking, and electronic mail exchange on broadband, Ethernet, and high-speed, fiber-optic, local-area networks, interconnecting corporate information systems and NRaD's minicomputers, workstations, and

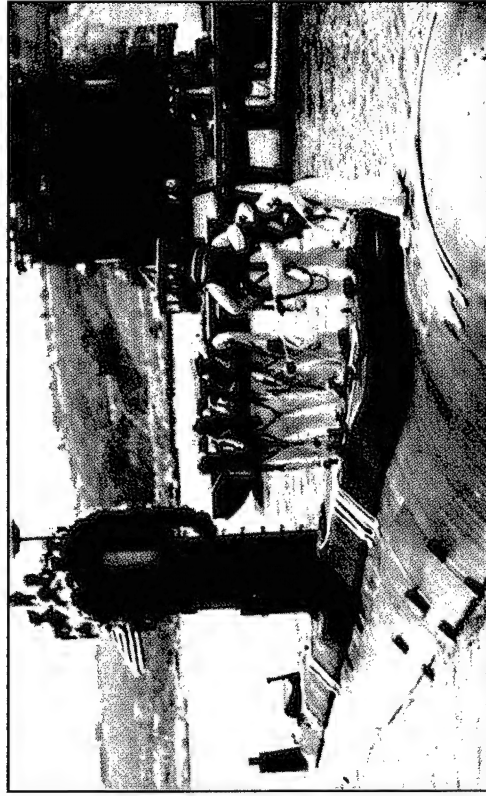


*TRANSDEC Facility at Night.*



*USS Dolphin enroute to NRaD, Bayside.*

personal computers throughout the San Diego complex and at NCCOSC field activities, and for connectivity with the external MILNET and commercial networks.



*USS Dolphin and crew arriving at NRaD, Bayside.*

## COMMAND, CONTROL, AND COMMUNICATIONS MODELING AND ANALYSIS

**Distributed Simulation Internet (DSI) Advanced Simulation Laboratory** complemented by secure DSI integration hardware, software, simulations, and gateways to other simulations.

**Marine Air Ground Task Force (MAGTF) Tactical Warfare Simulation (MTWS) Laboratory** for the development and testing of the MTWS system.

**Research, Evaluation, and Systems Analysis (RESA) Facility**, a large-scale, computer-based simulation/wargaming system used to support a variety of applications, including command, control, communications, and intelligence (C<sup>3</sup>I) architecture assessment, concept-of-operations development, advanced technology evaluation, joint exercises, and test and evaluation of advanced systems.

1996

## FLEET SUPPORT AND IN-SERVICE ENGINEERING

**AN/FRT ISEA Laboratory** that supports AN/FRT Series communications transmitters; provides capability for development of Engineering Change Proposals (ECPs), investigation of transmitter design problems, and simulation of fleet transmitter problems; and supports life-cycle engineering for Navy HF transmitters.

**AN/FRT-96 Interim Supply Support Facility (ISSF)** that allows for repair or replacement of failed AN/FRT-96 parts.

**Antisubmarine Communications Test Facilities** that allow integration testing, performance inspection, checkout assembly, and fleet support of Antisubmarine Communications Center systems.

**Automatic Test Equipment (ATE) Laboratory** that supports development, preparation, and maintenance of test program sets, and provides space for operation and maintenance training.

**CARBROC Processing and Display System (PDS/ILS) Laboratory** that provides testing, evaluation, life-cycle support capability, and ILS functions.

**Communications/TEMPEST Laboratory** that provides capability for instrumented and visual equipment survey, emanations analysis, and testing, evaluation, and pre-installation of communications equipment wiring.

**Cryptographic Repair Shop** that provides classified electronic equipment maintenance and repair capability.

**EHF, UHF, SHF Pre-Installation and Checkout (PITCO) Facility** that provides capability for pre-installation test and checkout of EHF, UHF, and SHF equipment.

**Electronic Maintenance Laboratory** that provides workstations for maintaining electronic/communications equipment.

**Environmental Laboratory** that provides electronic equipment temperature and vibration testing capability.

NRaD-17

**ESM Engineering Laboratory** that provides workstations for prototyping and engineering analysis of space and surface ESM systems.

**Fleet Maintenance Agent (FMA)/TSTP Laboratory** that provides in-service maintenance engineering, design analysis, and evaluation of the Satellite Navigation System, Naval Automated Communications Equipment, and the Message Processing Distribution System; supports in-service engineering and test procedure development for External Communications Systems and coordinates of Reliability Center Maintenance development.

**High-Frequency ISEA Laboratory** that provides ISEA capability and training on high-frequency radios.

**ICF VLF Systems Facility** that provides mockup of installed VLF submarine systems at shore sites and onboard naval vessels for simulation of problems and IV&V testing of software and prototype testing of hardware enhancements.

**Interior Voice Communications System (IVCS) Facility** that provides IVCS laboratory and classroom space.

**JTIDS ISEA and ISSA Laboratory** that assists in resolution of Fleet Trouble Reports and provides production engineering support and technical manual maintenance and validation.

**Metrological and Oceanographic (METOC) System Laboratory** that is a state-of-the-art systems integration lab for Navy and Marine Corps METOC equipment including line data sources.

**OUTBOARD Calibration Facility** that includes 60 acres of land to accommodate five HF, three VHF, and four UHF antennas for transmitting signals to OUTBOARD-equipped ships conducting calibration tests at sea.

**Radar Test Facility (RTF)** that allows testing of TACAN, PAR, and Marine Air Traffic Control and Landing System (MATCALs) systems.

**Radioactive Detection Indication and Calibration (RADIAC) Laboratory** that provides radioactive equipment repair and calibration capability.

**SATCOM Baseband PITCO Facility** that provides capability for pre-installation test and checkout of SATCOM baseband equipment.

**SATCOM ISEA Laboratory** that includes co-located laboratories for EHF, SHF, UHF, INMARSAT, and commercial SATCOM with full operational terminals.

**Tactical Systems Support Complex (TSSC) Facility** that supports engineering and technical services, configuration management, software maintenance, and repair of ESM systems; shop meets sensitive compartmented information security requirements.

**Tactical Van Maintenance, Test, and Certification Facility** that allows maintenance, test, certification, and customer acceptance of Navy Tactical Vans.

## NAVIGATION

**Aircraft Motion Simulator**, a fully automated simulator providing a dynamic test environment for evaluating aircraft navigation systems.

**Communications Laboratories**, providing the capability to design, simulate, develop, and test sophisticated components and airborne communication systems for military applications.

**GPS Central Engineering Activity (CEA) Laboratory** that provides a complete laboratory environment for test and evaluation of Global Positioning System (GPS) receivers.

**Navigation Sensor System Interface (NAVSSI) Laboratory**, a facility to develop and test the NAVSSI software and hardware before installation on ships and submarines.

**Ocean Survey Program and United Kingdom System Integration Laboratory (OSP/UK SIL)** that provides system development and integration of ocean survey systems prior to integration onboard ships.



## FACILITIES AND RESOURCES

**RF Microelectronics Laboratory**, a facility to design, develop, and create prototype state-of-the-art RF microelectronic circuitry using thick-film and thin-film technologies.

**Simulated Ship's Motion Facility (SCORSBY)**, a facility that houses two large ship motion simulators and that can test navigation systems weighing up to 3000 pounds.



*System Integration Laboratory.*

## TECHNICAL PROGRAMS

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### INTRODUCTION

#### Command and Control (C<sup>2</sup>)

NRaD provides full-spectrum research, development, test and evaluation, engineering, and fleet support within its assigned mission and leadership areas.

In command and control (C<sup>2</sup>), NRaD pursues an aggressive technology-based program that includes distributed C<sup>2</sup> technologies, information management, human systems interaction, modeling and simulation, advanced computing technologies, and Marine Corps technology applications. As an active participant in the Joint Directors of Laboratories Technology Panels for command, control, and communications; computer science; and human factors, NRaD leverages our Navy technology with those developments in the Army and Air Force. Transition of our technology base to evolutionary systems is our enduring goal.

NRaD's current C<sup>2</sup> systems development includes the Advanced Combat Direction System for command ships, the Joint Tactical Information Distribution System, the C<sup>2</sup> Processor, and the Joint Maritime Command Information System (JMCIS). JMCIS is a new architectural initiative that encompasses the Navy Tactical Command System-Afloat and the Operations Support System. JMCIS is an operational C<sup>2</sup> system that provides an integrated decision support capability for all levels of command, both ashore and afloat. Many of these C<sup>2</sup> capabilities have been integrated at the Caribbean Regional Operations Center (CARL-BROC) at Key West, FL, which is conducting surveillance missions for drug interdiction and tactical operations.

#### Communications

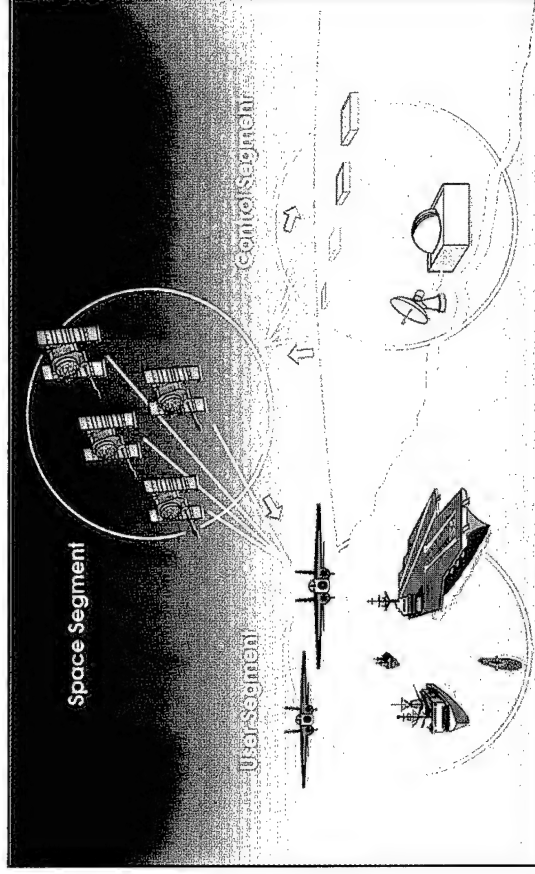
Communications of all types (e.g., wire, fiber optics, satellite, ATM) are the foundation for the C<sup>4</sup>I infrastructure. NRaD provides communications support for entire integrated systems as well as system architecture development. NRaD's leading role in the development and deployment of interoperable advanced communications for the joint warfighter on all platforms includes Lead Laboratory responsibilities for the Joint Maritime Communications Strategy (JMCOMS). NRaD also leads the Navy in extending the National Information Infrastructure and Defense Information Infrastructure to the theater through a high-data-rate wireless mobile network that optimizes the mix of commercial and military assets to ensure successful Expeditionary Force operations.

#### Surveillance

NRaD is charged with developing systems and technologies for the surveillance of air, surface, and undersea objects in and around ocean areas of operational interest, and with fusing multisensor information into an integrated theater and regional surveillance picture. Technologies and sensors include radar; microwave; millimeter wave; optical; electric and magnetic field; and passive and active acoustics and associated processing.

## Navigation

NRaD is the Navy's lead Navigation Center—developing and integrating navigation sensors and systems for all types of Navy platforms, including aircraft, ships, and submarines. Product lines include internal reference systems such as inertial, gravity, and absolute velocity; and external reference systems such as the Global Positioning System (GPS). NRaD is the GPS Program's Central Engineering Activity for GPS user equipment. In addition, under the Multimission Survey Program, NRaD implements this navigation technology to develop and maintain systems that produce ocean-bottom contour charts for use by the Fleet.



*Global Positioning System (GPS).*

## Ocean Engineering, Marine Mammals, and Marine Environmental Quality Assessment and Remediation

NRaD provides ocean engineering expertise in the areas of undersea research, survey, work, and reconnaissance systems. NRaD is also pursuing innovative research in robotics, materials, optical and acoustic undersea communications, and electro-optical and electromagnetic propagation.

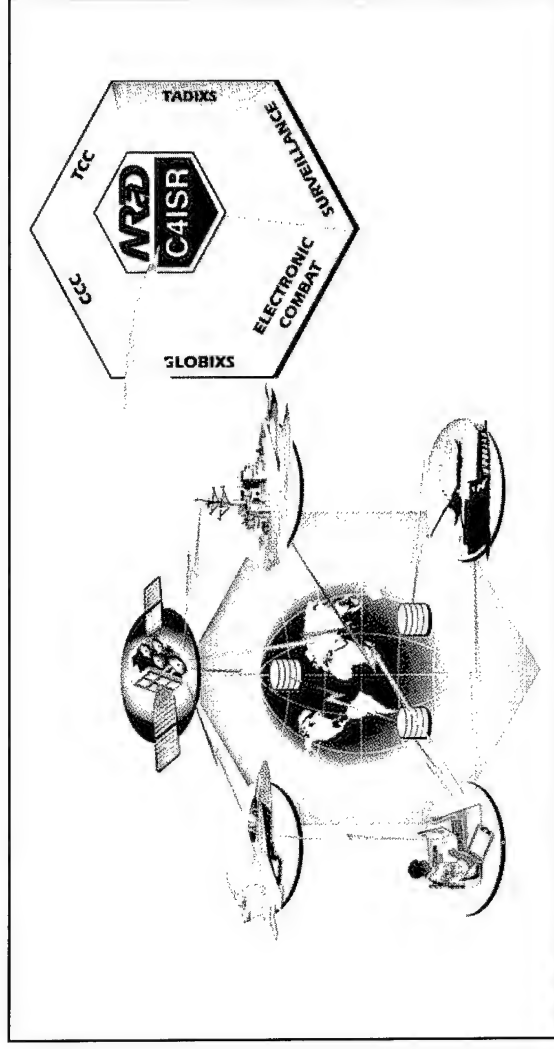
NRaD's RDT&E work with marine mammals has demonstrated that marine mammals can perform tasks related to object detection, location, marking, and recovery. Such work has also resulted in improved diagnostic and treatment techniques for marine mammals.

NRaD also develops marine environmental risk assessment and remediation technology, and, through its Marine Environmental Support Office, provides direct support for aquatic environmental issues to the Fleet and to Navy shore facilities.

## Integration of Overarching Multiplatform Systems

### TECHNICAL PROGRAMS

NRaD provides full-spectrum C<sup>4</sup>ISR RDT&E capabilities—from theater-level systems architecture through specific systems design, development, test, and evaluation to evolutionary program support. These capabilities are provided to Navy, Marine Corps, Joint, and Allied customers.



*NRaD's capability-based, Integrated Joint Perspective ensures sustainable C<sup>4</sup>ISR systems.*

## Fleet Support and In-Service Engineering

NRaD offers expertise and services in all aspects of system acquisition and in-service engineering support, including antenna design and location, data management, depot/overhaul development, hardware/software development and support, installation, logistics, and lifecycle services, product evaluation, propagation analysis, requirements analysis, security risk assessment, system integration, and system test and evaluation. NRaD provides a primary point of contact for Navy fleet activities. Support includes C<sup>4</sup>ISR enhancements, joint exercise support, technical assistance, C<sup>4</sup>ISR capabilities' briefs, and combat systems assessments and inspections. Off-site support includes shore and afloat platform integration; end-to-end systems testing, analysis, and validation; and site engineering.

## **Independent Research**

New and innovative ideas proposed by NRaD scientists and engineers are supported by the Executive Director through the use of discretionary funding provided by Independent Research (IR) programs. These programs support initial research in many areas of interest to the Navy, including command, control, communications, ocean surveillance, and navigation.

Specific technical programs, grouped by major areas of effort, are listed on the following pages.

## **TECHNICAL PROGRAMS**

## COMMAND AND CONTROL (C<sup>2</sup>)

**Advanced Combat Direction System Block 0 (ACDS Block 0).** Develop and maintain CV, CVN, LCC, LHA, and LHD combat direction system computer programs, other support programs, and related documentation.

**Advanced Combat Direction System Block 1 (ACDS Block 1).** Develop a replacement and upgrade for the Naval Tactical Data System, providing significant enhancements in sensor management, tactical data exchange, warfare area coordination, and system reliability.



*Advanced Combat Direction System.*

**Command and Control Processor (C<sup>2</sup>P).** Provide the centralized management and control of tactical digital information links in a multithreat environment.

**E-2C Airborne Tactical Data System Software Support.** Plan, design, construct, test, and deliver E-2C ATDS computer programs to the Fleet;

## TECHNICAL PROGRAMS

correct, update, modify, and distribute operational programs in accordance with evolving fleet requirements; provide ancillary computer programs to support life-cycle maintenance; provide technical assistance to shore sites; provide tactical, diagnostic, and support software of the highest quality; and rapidly respond to fleet requirements.

**High-Performance Computing (HPC).** Conduct HPC in support of all mission areas and technical endeavors in the Laboratory. Center-wide coordination facilitates and supports acquisition of state-of-the-art systems for local and shared HPC with focus on C<sup>2</sup> and embedded signal/image processing, as well as defense-wide network access to HPC systems throughout the DoD R&D laboratory community.

**Human-Computer Interface (HCI).** Lead the development of advanced HCI concepts for command and control and distributed simulation systems; integrate concepts into advanced C<sup>4</sup>I and simulation applications.

**Joint Maritime Command Information System (JMCIS).** Provide the primary C<sup>4</sup>I system for the U.S. Navy and Joint Task Force Commander. JMCIS is an integrated hardware and software product consisting of the core Unified Build segment and those segments developed by numerous agencies to meet specific operational requirements. NRaD provides systems engineering and integration and is the Software Support Activity.

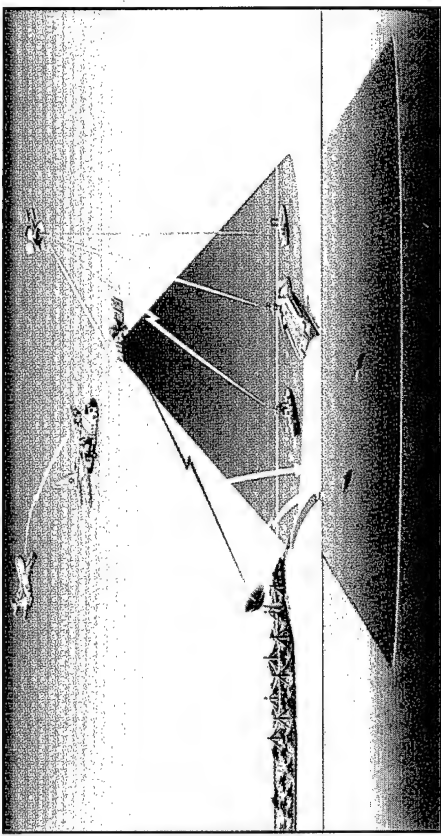
**Joint Tactical Information Distribution System (JTIDS).** Provide an integrated communications-navigation-identification system featuring multichannel, multinet, high-data-rate communications and relative navigation capabilities for tactical operations.

**Multifunction Information Distribution System (MIDS).** Built with more recent hardware, MIDS terminals provide JTIDS functionality with lower weight and cost. NRaD performs as primary USN systems engineer, supporting both the MIDS terminal development within the international community and its application in the U.S. lead platform, the F/A 18.

**Range Naval Tactical Data System (NTDS) Upgrade.** Upgrade the existing NTDS systems at the Atlantic Fleet Weapons Training Facility

(AFWTF), Puerto Rico, and the Pacific Missile Range Facility (PMRF), Hawaii, to current fleet standards.

## COMMUNICATIONS



*Full-Spectrum Communications.*

**Advanced Concepts in Communications.** Investigate advanced concepts in satellite communication systems; research and test issues of design improvements, vulnerabilities, and exploitation.

**Advanced Digital Networks.** Develop and implement advanced digital networks to accommodate multimedia user applications including data, voice, video, and imagery.

**Antenna Design and Modeling.** Design and develop advanced antenna concepts and systems for DoD platforms and systems, including designing, developing prototypes, and testing at NRaD facilities and on ships, systems, etc. Antennas include the Multifunction Electromagnetic Radiating System (MERS), spiral, Near Vertical Incidence Skywave (NVIS), current probe, loaded wideband, and other antennas.

**Application of Electromagnetic Technology.** Apply electromagnetic interference (EMI) engineering technology to measure, analyze, and mit-

igate EMI problems for DoD platforms, including computational electromagnetics, brass modeling, platform engineering, interference cancellers, composite masts, development and use of workstation tools, advanced technology demonstration EM projects, EM databases, and EMI measurement facilities.

**Automated Communications Management System (ACMS).** Provide system engineering, software development, testing, factory training, and installation for the ACMS. The ACMS, an element of the MILSTAR Mission Control Segment, provides for long-term, near-term, and day-to-day planning of the MILSTAR satellite communication system. The ACMS also performs MILSTAR performance monitoring and real-time control for the Army MILSTAR terminals.

**CIRCUIT MAYFLOWER Shore Automation System (CMSAS).** Provide automation and remote control for the nine CIRCUIT MAYFLOWER receive sites, thus greatly reducing the manning requirements and operating costs.

**Common Operational Modeling, Planning, and Simulation Strategy (COMPASS).** In support of DoD's C<sup>4</sup>I to SIM Initiative, provide services via middleware to C<sup>4</sup>I and modeling and simulation (M&S) systems so that live, virtual, and constructive simulations can be accessible to C<sup>4</sup>I/planning to gain insight into plans, based on results and feedback from M&S. The ultimate implementation of the concept is to use the same "virtual battlefield" to plan, replan, simulate, or train, providing M&S to C<sup>4</sup>I needs. This concept includes being able to access M&S to evaluate key decisions or entire plans.

**Communication Architectures.** Provide technical expertise and advisor support to OPNAV and SPAWAR in the development of communication architectures, system engineering, and program definition and development.

**Communications Software Support Activity (SSA).** Serve as the SSA for a variety of naval SATCOM programs. In this capacity, NRaD performs life-cycle support functions that include the following: instituting periodic Configuration Control Boards, providing configuration accounting reports to SATCOM Program Managers, receiving and



## TECHNICAL PROGRAMS

reviewing user software trouble reports, developing software change proposals in accordance with approved standards, preparing block software upgrades and associated software documentation packages, and performing software installation upgrades and fleet training for new system enhancements.

**Communications Software Technology.** Develop software tools, such as intelligent system agents and system objects, that promote software reuse across multiple projects.

**Communications Support Technologies.** Develop tools, such as emulators, source analysis tools, software language translators, and data reducers, that can be used in standard environments.

**Data Link Communications System (DLCS).** Provide SSN 637, SSN 688, and SSN 21 class submarines with a tactical communications capability that facilitates rapid, accurate, and successful targeting of hostile forces at ranges beyond line of sight (BLOS). This Over-the-Horizon Targeting (OTH-T) capability uses sensors on platforms other than the submarine, and is necessary to effectively use the weapons systems of the submarine. NRaD is the In-Service Engineering Agent (ISEA) for the AN/USQ-76(V)3 Data Terminal Set, the Link 11 Modem-Processor, and the J-3780/UYSK Sensor Interface Unit.

**Electromagnetics Technologies.** Develop communications and related technologies such as SOLDIER 911, a system that provides a border alert warning for aviators and the Universal Radar Moving Target Transponder (URMTT), which generates over-the-air radar targets for most radars, including frequency-hopping radars.

**FVLFF Navigation System.** Provide SSNs the ability to navigate while under the polar ice cap in the Arctic after the current OMEGA navigation system is closed in September 1997. The system will use the current Fixed VLF broadcast transmissions intended for communications.

**FVLFF Systems Engineering.** Provide VLF/LF coverage predictions (SCAT program) to the submarine fleet and upgrades to the submarine Fixed VLF/LF transmit sites.

**High-Data-Rate (HDR) Communications.** Develop HDR communications concepts and hardware, including HDR line-of-sight (LOS) UHF communications and HDR laser communications systems.

**High Data Rate (HIDAR).** Develop HIDAR, a Strategic Communications Connectivity (SCS) communications mode that provides greatly reduced delivery times for Emergency Action Messages while maintaining excellent performance in stressed communications environments. HIDAR combines state-of-the-art coding and signal processing to provide rapid and reliable command and control communications to our deployed strategic forces.

**Information Security (INFOSEC) Support to Programs.** Provide support to SPAWAR as the Information Security Software Support Activity (SSA). This includes the Navy Key Distribution System (NKDS), Embedded INFOSEC Product (EIP), Advanced Narrowband Digital Voice Terminal (ANDVT), and Automated Navy COMSEC Reporting System (ANCRS) and other related Information Security (INFOSEC) Systems.

**Information Security Systems/Architecture.** Integrate INFOSEC capabilities into naval C<sup>4</sup>I systems and architectures. Serve as liaison between SPAWAR, end users, and supporting contractors to maintain present capabilities and respond to present and future INFOSEC needs.

**Information Systems Engineering.** Provide technical support for integrating systems, including interior communications radio.

**Integration of C<sup>4</sup>I Systems.** Develop and integrate the Submarine Message Buffer and Navy EHF Communication Controller, Baseband Switch, JMCIS, JTIDS, and Link 11 into the Submarine Communications Support System (SCSS) architecture.

**Interior Shipboard Communications.** Develop components, data links, standards, specifications, and test procedures for shipboard



applications; apply data bussing/networking technology to shipboard information transfer problems; apply new techniques to increase flexibility, security, and survivability of communications aboard ships.

**Joint Maritime Communications Strategy (JMCOMS).** Implement the Copernicus architecture's communications segment. JMCOMS will leverage technology advancements and use communications assets efficiently to ensure information dominance. JMCOMS will conform to the architecture and standard objectives as mandated in the Technical Architecture for Information Management (TAFIM).

**Local-Area Networks (LAN)/Wide-Area Networks (WAN).** Develop LAN and WAN technology and architecture to provide high-data-rate connectivity between ashore and afloat locations; develop prototypes to standardize and facilitate sharing information.

**Military Sealift Command (MSC) Message Delivery Project.** Develop a project plan that presents an alternative method for the delivery of message traffic to and from MSC ships in a deployed and in-port status. The objective is to provide a more reliable, cost-effective method of message delivery for the MSC fleet.

**Mobile Communications Technologies.** Investigate, develop, and test technologies relating to satellite and mobile platform communications.

**Modeling and Simulation.** Provide verification testing and data population support for the Naval Simulation System; provide planning development simulation support; provide Functional Process Improvement (FPI) modeling in support of the Joint Maritime Operations (JMO) architecture project; develop computational electromagnetic models to support electromagnetic engineering analysis.

**Modified Miniature Receive Terminal (MMRT).** Deploy the MMRT in the National Airborne Operations Center (NAOC) and E-6B aircraft as well as the Minuteman Launch Control Centers to provide VLF/LF Strategic Communications Connectivity.

**Multiple Platform Links.** Provide system engineering, system development, and system testing of advancements in multiple platform communication links to ships and aircraft. This includes the application of HF for high-speed data service and automation of HF radio operation and circuit establishment.

**NATO Interoperable Submarine Broadcast System (NISBS).** Provide the capability to relay, format, and transmit NATO-compatible submarine broadcasts from U.S.-owned FVLF/LF transmitters. Two subsystems are installed at the broadcast transmit station, the STANAG 5030 Formatter and the Remote Monitor.

**Navy EHF Communications Controller (NECC).** Provide an integrated approach to future Navy communication systems. NECC is a sophisticated communications server used to transfer information between ships and between ship and shore installations. The NECC uses satellite connectivity to support tactical data information exchange system requirements of the Tactical Data Processors.

**Network Technologies.** Plan, design, develop, and test communications systems and multimedia technology.

**Range Extension Mode (REM).** Provide extended range and throughput for VLF/LF communications to the submarine fleet. REM uses new message compression and Error Detection and Correction (EDAC) algorithms to achieve greater range and throughput.

**RF Networks.** Plan, perform systems design, develop, and implement the total shipboard communications system; support development of an implementation approach for introduction of commercial/joint telecommunications standards, hardware, and software to support naval C<sup>4</sup>I systems.

**Satellite Communications Support.** Provide SATCOM support, including general system engineering, Independent Verification and Validation (IV&V), on-site technical support, engineering studies, and network monitoring.

**Satellite Communications Systems.** Provide system engineering, design, and development to the joint services in UHF, SHF, and EHF

satellite communications. This includes development of interoperability standards and protocols, and terminals and control systems for existing systems and developing systems.

**Signal Processing.** Provide system design, analysis, research, and computing for advanced HDR communication links, electro optics, and synthetic aperture radar (SAR) projects including TOPSIGHT, WAR-BREAKER, and Stochastic Target Detection and Recognition (STD/R); develop parallel computing algorithms for image formation and automatic target recognition.

**Strategic Submarine Communications System Engineering.** Provide technical leadership for the improvement and maintenance of the Strategic Connectivity System (SCS). The newest SCS mode developed greatly reduces Emergency Action Message delivery times without reduction in coverage. In addition, the program supports the Modified Miniature Receive Terminal (MMRT), the Non-Linear Adaptive Processor (NONAP), VLF systems development, and TACAMO message processing systems.

**SUBCOMM Architecture.** Support the design and development of architectures such as the Automated Communications Management System, a satellite communications management program, and the Submarine Communications Support System, whose goal is to eliminate reliance on stovepipe communication systems, provide transparent, assured communication and network management, improve communication through efficient use of channels, and make the submarine indispensable to the Battle Group.

**SUBCOMM Software Management Process.** Support the development and implementation of a Software Support Activity for the Submarine Message Buffer (SMB).

**SUBCOMM Technology.** Develop and improve technologies in areas that advance submarine communications and software engineering.

**Submarine Baseband Switch (BBS).** Provide a replacement for the multitude of communications patch panels currently fielded in the 688 class submarine radio room with a hybrid circuit switch consisting of a VME-based circuit switch and a COTS cross-point switch (SWITCHEX). BBS provides an intuitive JMCIS-compliant graphical user interface (GUI) to build and save communications circuits and communications plans with logging functions to assist the Submarine Communications personnel in managing and operating the radio room from a single C<sup>4</sup>I workstation.

**Submarine Communications Management.** Use existing VLF/LF transmitters to cost-effectively communicate with submarines anywhere through implementation of Consolidation of Broadcast Keying Sites, new flexible broadcast modes, and dynamic broadcast management.

**Submarine Communications Support System (SCSS).** Provide flexible and survivable communications through media sharing, multimedia access, and automated intelligent routing. The SCSS core elements consist of automated message handling, automated circuit switching, packet switching, and fully integrated network management and control of submarine communications.

**Submarine Low Frequency/Very Low Frequency VMEbus Receiver (SLVR).** Provide the SLVR as the submarine's future VLF/LF receiver, replacing the current VERDIN and Enhanced VERDIN systems. The receiver uses COTS and GOTS hardware and software in a VME chassis.

**Submarine Message Buffer (SMB).** Provide the first phase of the modernized submarine radio room program as described in the Submarine Communications Program Summary. The SMB streamlines radio room operations with message creation and modification, on-line storage, sophisticated message retrieval, automated shipboard message distribution, and the capability to transmit and receive messages via existing radio room equipment.

**Switching.** Develop switching systems to interconnect Navy computers and peripherals; define interface requirements; fabricate, install, integrate, and check out total systems.

**Terrestrial Communications Links.** Support planning, designing, developing, implementing, and testing of terrestrial radio frequency communication links using existing and new technology.

**Time and Frequency Distribution System (TFDS).** Develop a GPS disciplined rubidium- or quartz-based signal amplifier system with the capability to interface with Cesium standards and provide distribution outputs of low-noise precision frequency and time reference signals. Through its modular, expandable architecture, the TFDS can accommodate almost any reference signal requirement on virtually any type platform (surface, subsurface, shore, and aircraft).

**Upgrade Existing SUBCOMM Assets.** Lead in the upgrade of shore-based FVLF and HF systems, including those on hull, operations systems, ship-to-shore communications, and NATO and bilateral communications.

## SURVEILLANCE



*Surveillance.*

**Acoustic Sources.** Develop new acoustic projector and material technology to reduce the size and weight of low-frequency active surveillance systems. Integrate these compact source arrays on the four SURTASS SWATH-P platforms.

**Advanced Communications Intelligence (COMINT) Voice Processing ATD.** Combine voice processing algorithms for interference rejection, background noise recognition, automatic speaker and language identification, signal external information correlation, and language translation; the resulting tactical subsystem will automatically sort and analyze intercepted audio communications to find those of potential interest.

**Advanced Deployable System (ADS).** Develop a rapidly deployable surveillance capability for regional conflict scenarios.

**Advanced Sensor Applications Program (ASAP).** Investigate the application of advanced electro-optical sensors for non-acoustic, anti-submarine warfare (NAASW), including target detection, classification, and tracking. Project tasks include sensor development, testing, data processing, and system performance analysis.

**Advanced Submarine Tactical ESM Combat System (ASTECS).** Provide system engineering development and acquisition support for next-generation submarine ESM system.

**Autonomous Sensor Concepts Project.** Design and develop sensor and processing technologies for remote in-situ undersea surveillance.

**Bottom Limited Active Classification (BLAC).** Develop automated techniques for active sonar target classification to support surveillance and tactical systems in littoral waters against diesel-electric submarine threats.

**Central Imagery Office (CIO) Virtual Laboratory.** Provide technology insertion tool to facilitate R&D collaboration among six DoD intelligence developers: The Army Topographic Center, USAF Rome Lab, NRaD, National Exploitation Lab, National Security Agency, and the Defense Mapping Agency. Focus on imagery R&D, exploitation and analysis, and collaborative tools.

**CERCIS.** Provide the next-generation replacement of signals intelligence (SIGINT) Correlation of Recognized Emitters (SCORE) and SIGINT Universal Recognition Facility (SURF) analyst capabilities currently at operational SIGINT sites; design, develop, and implement all Navy-required capabilities for this theater-level system. CERCIS is installed at seven sites worldwide.

**Common Aperture Multi-Band Radar (CAMBR)** Develop CAMBR, a multimode/multifunction radar that uses simultaneous multiple microwave bands, multiple wideband channels, and numerous waveforms as the signal source for the radar. In addition, the radar employs an electronically steered multibeam wideband antenna system. High-data-rate complex signal processing is employed to detect and correlate the received complex signal structure prior to integrating the radar sensor information to the ship self-defense system. CAMBR is designed to improve detection, identification, and track of high-speed, low-altitude, and low radar cross section (RCS) antiship missiles.

**Common Integrated Platform.** Create a software environment based on Common Object Request Broker Architecture to facilitate integration of dissimilar applications that share objects.

**dbMASTER.** Develop, integrate, and maintain dbMASTER, a software application that provides the intelligence analyst with improved methods for sorting, examining, and fusing discrete information from a wide range of intelligence sources. It has been designed to provide intelligence analysts/specialists with tools that significantly enhance their ability to search a variety of intelligence database and reference publications from a single workstation using an intuitive, user-friendly, graphical interface.

**Deployable Autonomous Distributed Systems (DADS).** Identify and develop technology for the fusion and control of internal sensor data in a deployable autonomous (uncabled) distributed system in a littoral environment.

**Distributed Surveillance Technology.** Evolve shallow-water acoustic and nonacoustic distributed and deployable surveillance concepts

through the development, integration, test, and evaluation of prototype sensor system hardware; demonstrate feasibility, lower the risks and production costs, transition to industry, and support other 6.2 and 6.3 developmental programs; model the potential fusion architectures for system tradeoffs and performance evaluations.

**Fixed Distributed System (FDS).** Develop a low-frequency, fixed acoustic surveillance system that will serve as the base system for commonality between future surveillance systems such as the Surveillance Direction System (SDS), Sound Surveillance System (SOSUS), and Surveillance Towed-Array Sensor System (SURTASS) upgrades.

**Hayfield Multi-Chip Module.** Design cryptographic chip. With the National Security Agency (NSA) under the sponsorship of the Operational Support Office (OSO), the program will design a "crypto chip." This crypto chip, called the Hayfield Multi-Chip Module (MCM), has four channels of independently reprogrammable decryption with over-the-air-rekey (OTAR) capability. The MCM is designed to be compatible with the NSA-mandated Electronic Key Management System (EKMS), to be implemented in the year 2000, and is the planned replacement for the Ricebird crypto chip set that currently provides the KGR-96 decryption function in embedded crypto modules. The Hayfield MCM is planned to be used by the various USN, USAF, USA, and USMC tactical receiver system developers for designing embedded crypto modules.

**High-Frequency Surface Wave Radar (HFSWR) ATD.** Develop a HFSWR for earlier, over-the-horizon detection of low-flying, low-observable, high-speed, anti-ship missile threats. This radar will provide increased reaction time for ship defense and handover cueing of an engagement radar in range, velocity, and angle.

**Integrated Undersea Surveillance System (IUSS) Surveillance Direction System (SDS) Shore Systems Engineering.** Support the development of the IUSS integrated architecture and development of SDS, including system engineering, software testing/TECHEVAL, and pre-planned product improvement (P<sup>3</sup>I).

**Intelligence, Surveillance, and Reconnaissance (ISR).** Conduct demonstration of ISR, an over-arching collection of sensor, processing, fusion, display, and dissemination systems with interoperability standards that provide a consistent situation perception to the commander for resource allocation and to the warrior for targeting. NReAD will conduct an ISR demonstration during FY 96 to help define this revolutionary new capability. The demonstration will include the functions of assembling and disseminating the all-source-based information, thereby providing timely, accurate, fully integrated information as needed by the users.

**Low Earth Orbit (LEO) System Program Office (SPO) Support.** Provide technical expertise and systems engineering support for space systems, ground systems, and test systems. Conduct engineering validation of ground processing and recommend alternative approaches. Conduct a link closure/receiver characterization risk mitigation study including supporting measurements.

**Man Transportable SOCRATES (MTS).** Define, develop, and integrate the Man Transportable SOCRATES (MTS) system to operate as a stand-alone or as an adjunct to the Special Operations Forces Intelligence Vehicle (SOF-IV). MTS consists of one or more portable intelligence workstations, a Communications Interface Unit (CIU), and one or more peripheral device units (PDU's) in a modular LAN architecture. MTS must provide Joint Deployable Intelligence Support System (JDISS) or Special Operations Command Research Analysis and Threat Evaluation System (SOCRATES) access via Joint Worldwide Intelligence Communications System (JWICS) connectivity, an Electronics Intelligence (ELINT) capability, and interface with a variety of Special Forces communications systems.

**Marine Mammal Acoustic Tracking System (MMATS).** Exploit passive acoustic processing techniques to detect, classify, and localize vocalizing marine animals within a designated area of interest.

**Mobile In-shore Undersea Warfare-System Upgrade (MIUW-SU).** Upgrade existing MIUW vans through the addition of remote sensors,

enhanced C<sup>3</sup>, upgraded acoustic processing and electronic support measures (ESM).

**Multistatic Active Project.** Develop systems concepts for activation of shallow-water sensors; develop algorithms for reverberation suppression techniques that enhance detection performance.

**Non-Acoustic Distributed Systems Components (NDSC).** Develop non-acoustic sensors and signal processing technology to augment acoustic arrays for enhanced detection, tracking, and classification of diesel-electric submarines in shallow water.

**Project Spinnaker: Iceshelf-95.** Develop and deploy lightweight, low-power, low-cost ocean surveillance or sensor array systems. Such technology provides quick, covert, affordable, and rapidly deployable ocean surveillance/sensor capability. The immediate goal of Project Spinnaker is the deployment of arrays in the Arctic. Project Spinnaker is a joint U.S./Canada program. The U.S. (NReAD) is developing the array, node, and fiber-optic components; Canada is developing Autonomous Undersea Vehicle fiber-optic trunk cable deployment.

**Radiant Jade Demonstrations.** Demonstrate Near-Real-Time Electronic Order of Battle (NRT-EOB) updates for operational multiservice users deployed worldwide.

**Rapid Imagery Transmission (RIT).** Implement standards for rapid reporting of intelligence derived from imagery via near-real-time communications paths like the TRAP Data Dissemination System (TDDS).

**Relocatable Over-the-Horizon Radar (ROTHR) (AN/TPS-71).** Provide system engineering, test, and analysis of Block Upgrade enhancements; assure interoperability with ROTHR surveillance product customers to include CARIBROC and JIATF-East; provide production system engineering, installation, integration, and acceptance test support to the ROTHR Program Office at Commander, Naval Space Command, Dahlgren, VA; manage and administer the remaining portions of the ROTHR production contract (N00039-90-C-0027) to include installation of the AN/TPS-71 transmit and receive arrays in Puerto Rico.



## TECHNICAL PROGRAMS

optic technologies for all wet-end components, resulting in affordable surveillance assets.

**Surveillance Towed-Array Sensor System (SURTASS) and Low Frequency Active (LFA).** Provide system engineering for development efforts and conduct development, acceptance, and certification tests as Technical Development Agent (TDA).

**Tactical Cryptological Systems/Information Warfare Exploit.** Develop Afloat Tactical Cryptological Systems, including OUTBOARD/COBLU, Combat DF, Ship Signal Exploitation Equipment (SSEE), and Battle Group Passive Horizon Extension System (BGPHEs). Develop an open-systems architecture, called Cryptologic Unified Build (CUB), that provides a common operating system for afloat cryptologic applications that is JMCIS Unified Build compliant.

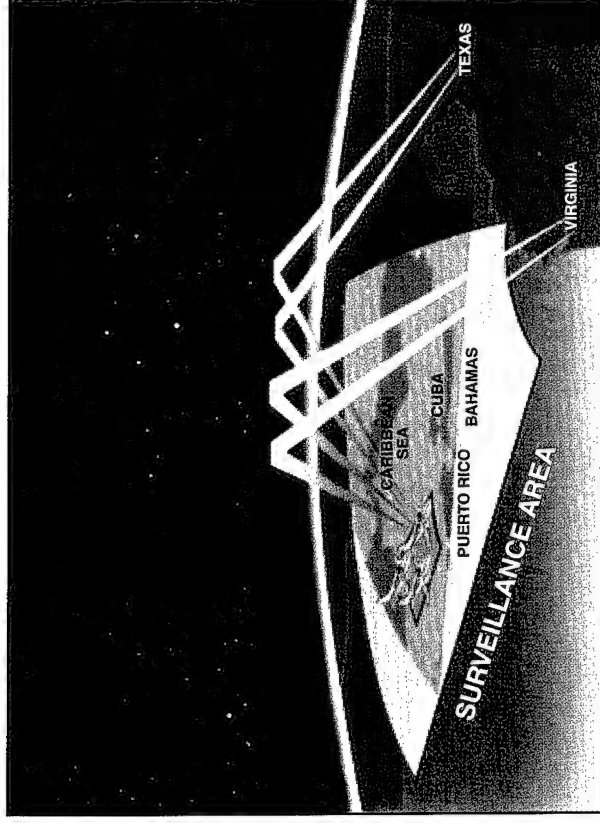
**Theater Acoustic Warfare (ThAW)/Data Fusion.** Develop advanced technology for theater-level systems that fuse undersea warfare data with other sources of data.

**Tomahawk In-flight Position Reporting System (TIPRS).** Develop the TIPRS ground-based Tomahawk Receiver Unit (TRU). When the TRU is located within the footprint of the relay satellite, it will provide missile position, missile health, and status information to the Tomahawk Mission Distribution System for up to 48 in-flight Tomahawk Transmitting Systems (TTS) equipped missiles simultaneously.

**TRAP Data Dissemination System (TDDS).** Develop a system that provides near real-time contact report data through a global netted message broadcast system to a variety of TRE users via the Navy UHF SAT-COM system and terrestrial communication links.

**Vertical Launch ASROC (VLA).** Support U.S. and FMS production of an intermediate range, all-weather, quick-reaction antisubmarine warfare (ASW) capability for the AN/SQQ 89(V).

**Virtual Laboratory.** Provide tools for collaboration among engineers at the National Exploitation Lab, NRaD, Rome Labs, and the Topographic Engineering Center. The virtual laboratory is an initiative of the Central Imagery Office.



*Relocatable Over-the-Horizon Radar (ROTHR).*

**Shipboard Infrared Search and Track.** Develop and maintain baseline algorithms for infrared missile detection and tracking; integrate software into hardware and test.

**Spatial Processing for Deployables/Robust Environmentally Based Adaptive Broadband Beamforming/Automated Track-Before-Detect Processing.** Develop improved passive detection processing for shallow-water deployable surveillance systems.

**Standard TRE Display 95 (STRED 95).** Develop a low-cost tactical display designed to exploit data received from national sensors via the Tactical Related Applications Broadcast System (TRAP), the Tactical Data Information Exchange Subsystem Broadcast (TADIXS B), or the Tactical Information Broadcast System (TIBS).

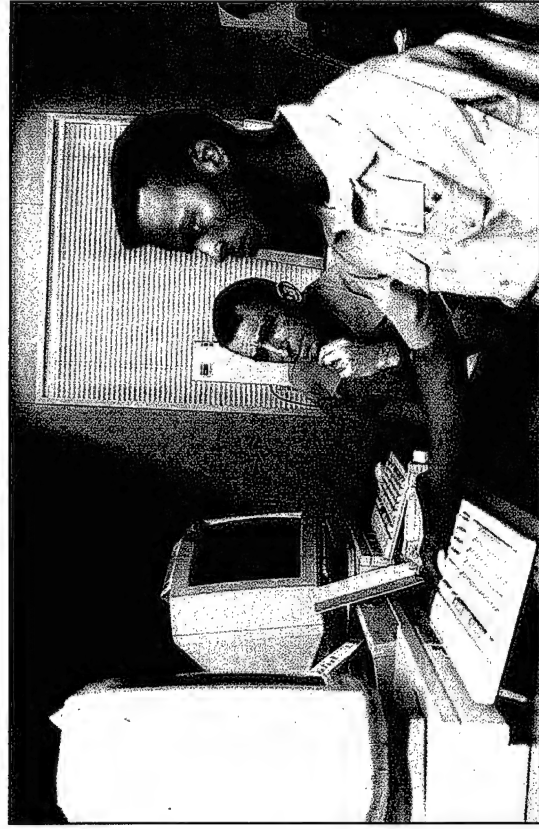
**Submarine Electronic Support Measures (ESM).** Provide software support, in-service engineering, logistics, and fleet support.

**Surveillance All-Optical Towed-Array (SAOTA) Program.** Design and develop a prototype array for surveillance applications using fiber-

## COMMAND, CONTROL, AND COMMUNICATION MODELING AND ANALYSIS

**C<sup>3</sup> Simulation and Technology.** Advance the technologies of large-scale simulation and networking and assess next-generation technologies to advance C<sup>3</sup> systems/information systems.

**MAGTF Tactical Warfare Simulation (MTWS) System.** Provide the next-generation Marine Corps Tactical Training System.



*MAGTF Tactical Warfare Simulation (MTWS) System.*

**Research, Evaluation, and Systems Analysis (RESA).** Provide a large-scale computer simulation/wargaming system supporting architecture assessment, concept of operations development, advanced technology evaluation, joint exercises, and test and evaluation of advanced systems.

## TECHNICAL PROGRAMS

### NAVIGATION

**Air Navigation.** Provide basic analysis and systems development functions for airborne navigation systems, including hybrid navigation systems and inertial navigation subsystems; develop experimental navigational systems and perform feasibility demonstrations aboard air platforms; provide engineering support to major system project offices in the areas of navigation and systems integration.

**Global Positioning System (GPS).** Provide accurate, continuous, worldwide, three-dimensional position and velocity and precise time to all DoD users through development and applications engineering of the GPS user equipment for Navy aircraft, surface ships, and submarines; manage, direct, and/or coordinate other participating activities and industry in support of the Joint Service Program as the Navy's lead laboratory in GPS user equipment.

**Navigation Sensor System Interface (NAVSSI).** Develop an interface designed to integrate the shipboard navigation sensors and systems and to provide a single best source of navigation information to all users; develop and provide preplanned product improvement of the NAVSSI, including incorporation of ship navigation planning aids, digital nautical charts, plotting capabilities, addition of navigation sources and users, and accuracy improvements.

**Navigation Technology Programs.** Perform research and development for navigation systems unique to Navy applications; perform research and development to improve or develop new navigation systems and applications.

**Ocean Survey Program (OSP).** Produce ocean bottom contour charts for direct use by the Fleet using a precise navigation subsystem and a multibeam sonar array subsystem integrated with an advanced data processing complex. Conduct a continuous program to extend the capability, accuracy, reliability, and maintainability of these systems by advancing the state-of-the-art in navigation, sonar, and data enhancement techniques in response to increasingly stringent fleet requirements for bathymetry, gravity, magnetics, and other geophysical parameters.

## TECHNICAL PROGRAMS

**MAGELLAN and Other Systems.** Provide ocean engineering wet-end support for undersea surveillance systems, including MAGELLAN and Advanced Deployable Systems.

**Mine Neutralization System (MNS).** Provide engineering and management support for the AN/SLQ-48(V) MNS, including the unmanned, tethered Mine Neutralization Vehicle (MNV).

**Mobile Detection, Assessment, and Response System (MDARS).** Develop and implement an automated intrusion detection and inventory assessment capability for use in DoD warehouses and storage sites. MDARS will provide multiple mobile platforms that perform random patrols in interior and exterior warehouse and storage site environments. MDARS is a joint service program. NRaD provides Technical Direction for the Interior and Exterior MDARS programs and is developing the Multiple Host Robot Architecture (MHRA) that will control and coordinate many autonomous robotic platforms.

**Telerobotics.** Develop C<sup>3</sup> architectures that can supervise multiple autonomous (robotic) platforms for physical security and other Navy applications.

**Unmanned Undersea Systems.** Develop unmanned undersea systems for search and work systems and major mission requirements. Provide technical support to Submarine Development Group One for deep ocean manned and unmanned systems.

## MARINE MAMMAL SYSTEMS (MMS)

**Marine Mammal Systems (MMS).** Develop, produce, and support operational fleet MMS for object detection, location, marking, and recovery missions; enhance MMS for MCM, develop improved methods for care and maintenance of marine mammals and to predict performance on long-term deployments to a variety of environments. Support efforts in determining the impact of Navy tests and operations on marine mammals in the wild. Conduct research in biosonar.



*Ocean Survey Program.*

**Ring Laser Gyro Navigator (RLGN).** Develop and transition the RLGN, the next-generation inertial navigation system for surface ships, into the Fleet. Make subsequent product improvements as TDA; provide an extended performance capability, a significantly improved reliability, and a much lower life-cycle cost.

## OCEAN ENGINEERING

**Air-Mobile Ground Security and Surveillance System (AMGSSS)** Design, develop, and demonstrate a rapidly deployable, air-mobile, sensor system that will provide extended range surveillance, detection, and identification of hostile ground forces for both personnel and vehicles for force protection and tactical security. The system consists of three air-mobile remote sensing packages and a controlling base station.





*Dolphins at NRaD.*

## INTEGRATION OF SPACE COMMUNICATION AND SURVEILLANCE SYSTEMS

**AN/USQ-101(V) Tactical Data Information Exchange Subsystem Broadcast (TADIXS B) Tactical Receive Equipment (TRE) System.** Develop a system that receives, demodulates, decodes, decrypts, processes, and distributes TADIXS B broadcast contact reports.

**Multimission Advanced Tactical Terminal (MATT).** Maintain MATT, a receiver system that allows the user to simultaneously receive, decrypt, filter, correlate, and distribute the data contained on up to four UHF broadcasts.

**Tactical Related Applications Broadcast System (TRAP).** Develop a system that provides near real-time contact report data through a global

netted message broadcast system to a variety of TRE users via the Navy UHF SATCOM system and terrestrial communication links.

## ELECTRONIC SCIENCES AND TECHNOLOGY

**Advanced Photonics.** Develop advanced photonics for shipboard antenna systems.

**Cryogenic Magnetometer.** Fabricate a high-temperature superconductor-based Superconducting Quantum Interference Device (SQUID) monolithically integrated with silicon circuitry on the same sapphire substrate.

**Infrared Focal Plane Array (IRFPA).** Test and evaluate Long-Wave Infrared (LWIR) focal plane arrays, detectors, filters, and materials in support of DoD and NASA technology and system development programs. Conduct research and provide consultation on infrared focal issues related to infrared radiometry and environmental effects for both strategic systems and orbital missile defense programs.

**Low-Power Electronics.** Support the Low-Power Electronics Program by attending reviews, characterizing wafers, and developing fabrication processes.

**Memory Chip.** Develop nonvolatile memory for strategic applications.

**Polarization-Independent Narrow-Channel (PINC) Wavelength Division Multiplexing (WDM).** Investigate index of refraction changes in fused fiber devices. This includes permanent changes due to irradiation with high-intensity ultraviolet light, and temporary changes due to absorption changes in couplers made with rare-earth-doped fibers when they are optically pumped.

**Reduced-Power Digital Filter (REDFIL).** Develop extremely low-power and high-speed analog-to-digital and digital-to-analog converter technology and devices.

**Silicon-on-Sapphire (SOS).** Exploit SOS technology for next-generation electronics and unique DoD applications.

**Stochastic Resonance (SR).** Conduct basic research on SR effect in noisy nonlinear dynamic systems; enhanced SR effect in many-body systems; role of SR in information/signal processing by sensory neurons; application to SQUID sensors for military/civilian remote sensing applications; and signal-detection statistics of nonlinear dynamic sensors.

**Trident Missile.** Provide navigation and fire control support for Trident missile programs.

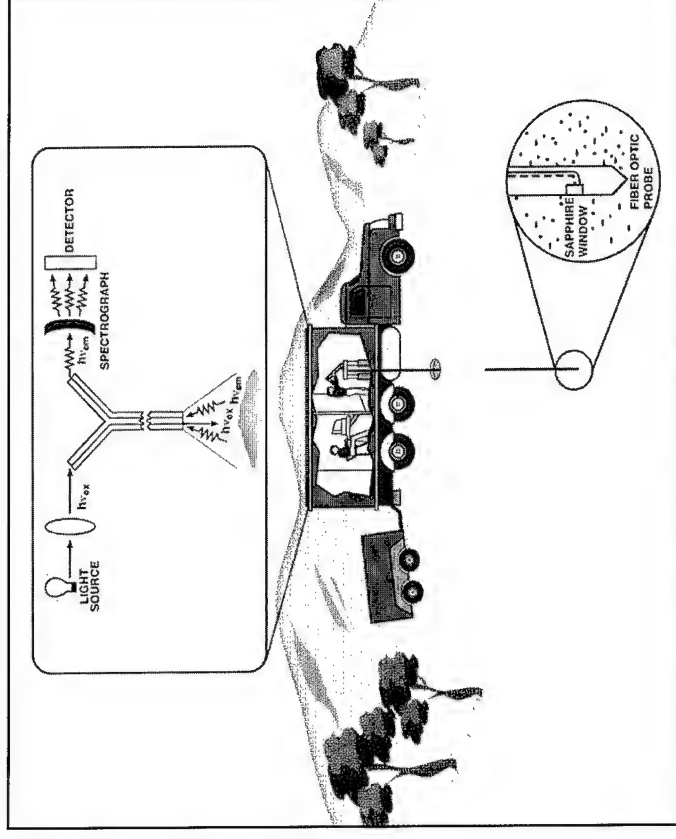
**Tri-Service Support.** Support the emulation of integrated circuit components no longer commercially available but needed to support fleet systems.

## ENVIRONMENTAL ASSESSMENT

**Marine Environmental Support Office (MESO).** Provide Navy-wide technical and scientific support and research for marine environmental science, protection, and compliance; provide expanded support on a cost-reimbursable basis for various sponsors.

**Site Characterization and Analysis Penetrometer System (SCAPS).** Develop and deploy a fiber-optic-based, laser-induced fluorescence sensor for petroleum, oil, lubricant (POL) contaminants for rapid assessment of hazardous waste sites at reduced costs.

**Waterside Security System (WSS).** Develop an integrated multiple-sensor system designed to detect, classify, localize, and assess waterborne threats attempting to gain access to critical DoD assets. These critical assets include moored ships, nuclear and conventional ordnance handling piers, installations where nuclear-capable ships moor, shipyards, naval facilities with classified material, and waterfront facilities.



*Cone Penetrometer Fiber-Optic Fluorometer (Double Fiber System).*

## FLEET SUPPORT AND IN-SERVICE ENGINEERING

**Air Force Joint Tactical Information Distribution System (JTIDS) Interface Box.** Perform system engineering, production, and technical support.

**AN/BLD-1; AN/BQH-5; AN/BQH-9; AN/BRD-7; AN/WLQ-4; AN/WLQ-4(V)1; AN/WLR-1H; and AN/WLR-8 Submarine ESM Systems.** Provide software/hardware engineering, ISE, and fleet support.

**AN/TSC-131 JTIDS.** Design, develop, fabricate, and test engineering development model (EDM) systems.

**Announcing Systems.** Perform as ISEA.

**Battle Group Passive Horizon Extension System (BGPHERS).** Provide system engineering and software development.

**C<sup>4</sup>I Briefing Books.** Develop and update briefing books for deploying Carrier Battle and Amphibious Readiness Groups.

**Caribbean Regional Operations Center (CARIBROC).** Perform as In-Service Engineering Agent (ISEA).

**Combat Direction Finder (DF).** Provide system engineering and software development.

**Combat Systems Readiness Review (CSRR).** Perform system material assessment of Pacific Fleet.

**Command Center Network Phase II (CCN2).** Perform as ISEA.

**Commercial SATCOM.** Perform as ISEA. Perform system design, engineering, and integration.

**Data Link Communications System (DLCS).** Provide engineering and technical support.

**Digital Photo Lab (DPL).** Perform system engineering.

**Direct Air Support Central (DASC).** Provide fleet technical assistance.

**Doppler Sonar Velocity Log (DSVL).** Perform as ISEA.

**EHF SATCOM.** Perform as ISEA; provide fleet support and installation.

**Field Change Installation Program (FCIP).** Provide material and technical support.

**Fleet Electronic Warfare Support Group (FEWSG).** Provide design, acquisition, production, and field support.

**Fleet Hospital Communications Van.** Perform as ISEA.

**Inspection and Survey (INSURV).** Provide material condition inspection and survey of Pacific Fleet.

**Integrated Submarine Automated Broadcast Processing System (ISABPS).** Provide design and life-cycle support.

**Integrated Voice Control Systems (IVCS).** Perform as ISEA.

**JTIDS.** Provide intermediate life-cycle software support; perform as ISEA.

**Landing Systems.** Provide lead field activity support for new systems.

**Link-16 In-Service Support.** Provide in-service engineering (ISE), maintenance, integrated logistics support (ILS), and life-cycle support.

**Link-16 Project Office (LPO).** Provide Navy single POC field office for all fleet support and coordination of life-cycle technical and financial issues among all support activities.

**Marine Air Traffic Control and Landing System (MATCALS).** Provide technical support, installations, and emergency repair, alignment, and calibration of systems.

**Mobile In-shore Undersea Warfare (MIUW).** Perform as ISEA.

**Multifunctional Information Distribution System (MIDS).** Provide intermediate software life-cycle support and ILS.

**NATO Interoperable Submarine Broadcast System (NISBS).** Provide design and life-cycle support.

**Navigational Aids (NAVAIDS).** Perform as ISEA and Cognizant Field Activity (CFA).

**Navy Tactical Command Systems-Afloat (NTCS-A).** Provide engineering and fleet technical assistance.

**OMEGA.** Perform as ISEA.

**OUTBOARD (Shipboard Tactical Signals Exploitation/Direction Finding System).** Provide system engineering and software development.

**Pacific Missile Range Facility (PMRF).** Provide program management, radar design, engineering, and installation.

**Position Location Reporting System (PLRS).** Perform as ISEA.

**RADAR.** Provide program management; perform radar system design, engineering, and installation support.

**SATCOM—SHF/EHF/UHF, AUTO/TACTICAL Information Exchange System (IXS).** Provide system engineering, design, and field assistance.

**SHF SATCOM.** Perform as ISEA; perform system design, engineering, integration, and installation.

**Shipboard Communications.** Provide engineering; provide fleet technical assistance on external communications and peripheral systems.

**Ship Service Telephone Systems (SSTS).** Perform as ISEA.

**Ship Signal Exploitation Equipment (SSEE).** Provide software development.

**Shore Communications.** Provide system engineering.

**Southern California Offshore Range (SCORE).** Provide testing and operations assistance.

**Special Communications (SPECOMM).** Provide system engineering.

**Submarine LF/VLF VME Receiver (SLVR).** Provide design and life-cycle support.

**Surface Electronic Warfare (EW).** Provide acquisition, production, and test support.

**Systems Replacement and Modernization (SRAM).** Provide design for upgrade of test ranges.

**Tactical Air Navigation (TACAN).** Perform as CFA.

**Tactical Data Information Exchange System (TADIXS).** Perform as ISEA.

**Tactical Environment Support System (TESS).** Provide ISE, design, maintenance, and life-cycle ILS.

**Tactical Intelligence (TACINTEL).** Perform as ISEA.

**Telecommunications.** Provide program management, installation design, and system engineering.

**Time and Frequency Distribution System (TFDS).** Provide system engineering.

**Total Ship Test Program (TSTP).** Perform as ISEA.

**UHF SATCOM.** Perform as ISEA; provide design, engineering, integration, and installation.

**United States Agency for International Development (USAID) Very Small Aperture Terminal (VSAT) Network.** Provide installation and network implementation.

**VERDIN.** Provide design and life-cycle support.

## **INDEPENDENT RESEARCH (IR)**

**Independent Research.** Conduct research important or promising to the accomplishment of assigned missions; develop and maintain a cadre of active researchers in order to distill, modify, and refine research results that can be applied and transitioned to higher categories of the Navy's RDT&E program.

## TECHNICAL ACCOMPLISHMENTS (FY 95)

### COMMAND AND CONTROL (C<sup>2</sup>)

**ACDS Block 0.** Delivered Level 9 LHD R9.13 program version to the Integrated Combat Systems Test Facility for the start of LHD Combat Systems Integration Testing (CSIT) retest; delivered a CV Level 9 R9.13 version for use in preparation for dual-net/multifrequency link tests; installed Level 9 program at Fleet Combat Training Center, Pacific (FCTCPAC); installed Level 9 program version R9.16 onboard USS *Kitty Hawk* (CV 63); installed Level 9 Engineering Development Model program onboard USS *America* (CV 66); installed Level 9 program version R9.16 onboard USS *Boxer* (LHD 4); completed ACDS Block 0 Level 9 combined CV/CVN/LHD fleet Delivery Readiness Review process and authorized for fleet release; installed Level 10 program at LHD 5 Combat Systems Assembly and Checkout Facility (CSACF) in Pascagoula, MS; successfully completed Level 9 Navy and Joint Link-11 Certifications conducted by the Navy Center for Tactical Systems Interoperability (NCTSI).

**ACDS Block 1 Level 1.** Completed Level 1 Program Acceptance Test (PAT) and delivered Level 1 computer program upgrade to Integrated Combat Systems Test Facility for CSIT; conducted initial data link testing; applied results of PAT, CSIT, and data link testing development of Level 2 computer program; completed development of training materials required for Level 1 operator training.

**ACDS Block 1 Level 2.** Completed Preliminary Design Review and Critical Design Review of Level 2 computer program and associated hardware; installed Level 2 test beds at NRaD and the Fleet Combat Training Center, Atlantic (FCTCLANT); continued development of Level 2 computer program for delivery into PAT and CSIT during the first quarter of FY 96; specified all changes to Level 1 training materials required for Level 2 operator training; and completed analysis and design of Level 2 Interactive Courseware to support Level 2 operator training.

**Command and Control Processor (C<sup>2</sup>P).** Participated in the successful JTIDS/C<sup>2</sup>P Operational Evaluation (OPEVAL). Delivered C<sup>2</sup>P Model 14 to USS *California* (CGN 36), USS *Arkansas* (CGN 41), USS *Nimitz* (CVN 68), USS *George Washington* (CVN 73), USS *Callaghan* (DDG 994), USS *Anzio* (CG 68), USS *Cape St. George* (CG 71), USS *Enterprise* (CVN 65), USS *Port Royal* (CG 73), and USS *Shilo* (CG 67). Following a 1-day installation, *Shilo* was underway within 24 hours and demonstrated full operational capability in less than 48 hours.

**Command and Control Processor (C<sup>2</sup>P) Rehost.** Successfully tested the exchange of Link-11 messages in both directions. Rehost Model 4 is scheduled for delivery in March/April 1996 and Model 5 in March/April 1997. The C<sup>2</sup>P is being rehosted from the UYK-43 to the TAC-4. USQ-69 C<sup>2</sup>P human-machine interface (HMI) screens have been ported to X-Windows. With the exception of recoding the HMI and the input/output in "C" language, the C<sup>2</sup>P software programs will be maintained in their original CMS-2 language in the TAC-4.

**E-2C Airborne Tactical Data System Software Support.** Updated and delivered software version J5 (Group II) in response to urgent requirement from VAW-117. Software version J5 (Group II) passed Navy Interoperability Certification Testing for Link-16 performed by the NCTSI. Software version J5 (Group II) participated in Joint Interoperability Certification Testing for Link-16: Developmental Certification Test (DCT-002). Software version P9 (Group 0) underwent final Software Trouble Report (STR) correction and preparation for Navy and Joint Link-11 certification testing and subsequent delivery to the Fleet.

**Global Command and Control System (GCCS).** Provided engineering, database tailoring, software installation, and on-site support for a GCCS demonstration at the Joint Demonstration and Evaluation Facility (JDEF), Arlington, VA. The demonstration concentrated on GCCS Intelligence applications (JMCIS-based); demonstration software was an initial version of GCCS 2.0.



**High-Performance Computing (HPC).** Implemented major upgrades to both NReD HPC systems that form the core of the San Diego DoD HPC Distributed Center—Convex Exemplar SPP-1000 (4X increase in processors with 8-GB memory and 160-GB disk storage) and Intel Paragon XP/S-25 (increase memory 2X to 14 GB and disk to 128 GB, addition of archival storage system). Presented computational science and HPC applications work for both NReD and the DoD HPC program at Supercomputing '95. This year's NReD demonstrations included the following: digital libraries' research implemented on distributed, parallel processors; Scalable, Parallel Testbed for Radar Imaging, featuring Khoros and Max Planck Institutes (MPI) (Potsdam, Germany); application of signal detection algorithms to radar returns in sea clutter; Scalable Programming Environment, a software development environment for scalable dataflow applications; SmartNet, the Supercomputing '94 award-winning scheduler for heterogeneous distributed computing; and Visualization models—contaminant transport with fuel spill, ship antenna electromagnetic fields, and turbulent flow control. DoD demonstrations spanned the R&D HPC work in all the Services. NReD also received initial funding to begin participation in a new defense scaleable software development initiative, totaling \$2.45M annually in three of the DoD-designated computational technology areas: Computational Electromagnetics and Acoustics, Signal/Image Processing and Forces Modeling, and Simulation/C4I.

**Human-Computer Interface (HCI).** Completed a script and filming for a video depicting C<sup>4</sup>I in the 21st century using advanced HCI interfaces. A prior edition was incorporated into the NReD Command Center of the Future and presented to many Center visitors. The Command Center was upgraded with improved displays, computer-based presentation capabilities, and demonstrations of advanced DARPA HCI products.

**Joint Maritime Command Information System (JMCIS).** Continued to provide system engineering and installation support of JMCIS 2.1 systems on a worldwide basis. Work sites included C7F/USS *Blue Ridge* (LCC 19) in Japan; the Fleet Ocean Surveillance Information Facility in Rota, Spain; and the Commander, United States Naval Center (COMUS-

NAVCENT) in Bahrain. Installed the JMCIS 2.1 Central Data Base Server (CDBS) at Naval Surface Warfare Center Dahlgren Division (NSWCDD) for Joint Service Imagery Processing System-Navy (JSPS-N) land-based testing; also installed JMCIS 2.1 at the Navy Marine Corps Intelligence Training Center (NMITC) to support General Intelligence and Imagery Training; began the first allied 2.1 installation at the Canadian Maritime headquarters in Halifax, Nova Scotia.

**JTIDS/Command and Control Processor (C<sup>2</sup>P).** Completed JTIDS/C<sup>2</sup>P OPEVAL during USS *Carl Vinson* (CVN 70) Battle Group deployment in the Persian Gulf and while transiting the Pacific and Indian Oceans. NReD was a key player in the Technical Evaluation (TECHEVAL) events leading up to this very successful step in the deployment of JTIDS and C<sup>2</sup>P. The Commander, Operational Test and Evaluation Force (COMOPTEVFOR) Link-16 OPEVAL report of 19 October 1994 stated that all Critical Operational Issues (COIs) were satisfied and that both JTIDS and C<sup>2</sup>P would be recommended for fleet introduction.

**Multifunction Information Distribution System (MIDS).** Initiated MIDS effort at NReD. Startup in FY 95 included modification of the JTIDS Systems Integration Facility (SIF) to support F/A-18 integration and MIDS DT II testing.

**Range Naval Tactical Data System (NTDS) Upgrade.** Achieved Initial Operational Capability (IOC) at AFWTF in December 1994 and at PMRF in June 1995; transitioned into role as Cognizant Field Activity (CFA) for life-cycle support of the Range NTDS Upgrade System (RNUS) system.

**Tactical Data Link (TADIL) Gateway.** Accepted for joint testing. As a result of the Joint Interoperability Test Command's (JITC's) successful use of the TADIL Gateway in Developmental Certification Test 001 (DCT-001) of the E-2C and F-14D, JITC released official correspondence stating that the NReD TADIL Gateway "approach to TADIL-J testing represents a significant reduction in JTIDS terminal requirements for those services and agencies with their own RF network."



## COMMUNICATIONS

**6X8 Si-ADP Detector Array.** Designed, built, and tested the first 6X8 Si-ADP detector array. Single photon detection was accomplished with Geiger-mode ADP, 7-cm range resolution. A design was completed and fabrication started on a short pulse (2-nsec) transmitter.

**Advanced Concepts in Communications.** The Geolocations of Radio Frequency Interference (GOFRI) system was installed and accepted for operation at Naval Space Command where it is used to monitor interference on the UHF SATCOM system. The POWER geolocation subsystem was delivered to U.S. Space Command and installed in the POWER workstation. DAMA vulnerability simulations and experiments were completed and delivered to SPAWAR. Geolocation simulations were completed and delivered with test for inclusion in the Phase I report.

**Advanced Digital Networks.** Developed an interoperable network system linking the NATO countries.

**AEGIS Advance Planning Cell (APC).** FY 95 efforts supported AEGIS Advance Planning Cell (APC). Activities included participating in numerous APC and AEGIS planning meetings; coordinating NRaD presentations to the APC; preparing meeting minutes; participating with the planning and execution of the Office of the Secretary of Defense (OSD)/AEGIS Defense Infrastructure (DII) Symposium; and providing technical evaluation and recommendations to AEGIS-related manufacturing technology proposals.

**Analytical Solutions.** Demonstrated the significant gains that can be achieved with spatial temporal processing of multichannel receivers in a fading multipath environment. A paper describing the results obtained received the award for the Best Unclassified Technical Paper at the '95 IEEE Military Communications Conference in November.

**Automated Communication Management System.** Developed the system-level specification and system architecture. The first of several increments was also delivered to the MILSATCOM Joint Program

Office. The Automated Communication Management System project was a new start in FY 95.

**Awase Feed-Through Bushing.** Under the FVLF Systems Engineering effort, successfully designed and tested a new feed-through bushing and associated corona rings to be installed next year in the helix house at LF Awase. The new bushing has a wet withstand voltage of 155 kV versus an 83 kV rating on the old bushing.

**Baseband Switch (BBS).** Installed BBS Integrated Network Manager (INM) software release 4.1 in the Land-Based Submarine Radio Room (LBSRR) at Naval Undersea Warfare Center, New London detachment; successfully completed an Operational Assessment by COMOPTEVFOR in May 1996. BBS is being installed in the USS *Annapolis* (SSN 760) July 1996, the first shipboard deployment of the system. Produced the system/segment specification, developed the software, and completed the installation of the Integrated Network Manager and BBS fleet software, with documentation. This suite also included COTS and GOTS hardware.

**CIRCUIT MAYFLOWER Shore Automation System (CMSAS).** Successfully established Phase I of Remote Site #4 (RS-4) and link connectivity between RAF Croughton, UK, and NCTAMS SPECOMMDIV LANT Norfolk, VA. Completed the CMSAS Phase III upgrade and reconfiguration installation of ARWS at NCTAMS SPECOMMDIV EASTPAC Honolulu, HI, and at NCTAMS SPECOMMDIV WESTPAC Guam, Marianas Island. Successfully completed the installation of CMSAS "Final" Phase II at Elmendorf AFB in Anchorage, AK, and upgrade and reconfiguration at Athens, Greece; at Muscat, Oman; and at NCTAMS SPECOMMDIV EASTPAC Honolulu, HI.

**Common Operational Modeling, Planning, and Simulation Strategy (COMPASS).** Provided extensive exercise support for Commander U.S. Second Fleet during FY 96. During JTFEX-96-1, COMPASS was used to integrate Theater Missile Defense (TMD) planners from all the U.S. armed forces. CJTFEX-96 expanded on the TMD planning concept to include allied participation. Currently, two COMPASS-capable systems (TAMPS and CAPS) have successfully integrated in the GCCS Defense Information Infrastructure Common Operating Environment (DII COE).

Finally, a COMPASS-capable version to the Air Force Mission Support System (AFMSS) will be completing its final test certification.

**Communication Architectures.** Provided communication system experts onsite to SPAWAR, OPNAV, and Australia. Ensured that international Data Exchange Agreements have been properly executed. Developed Minimum Essential Interoperability Support document and commenced preparations for the 35th C<sup>3</sup> Board/11th Supervisory Board Meetings.

**Communications Software Support Activity.** Performed as Software Support Activity (SSA) for Tactical Receive Equipment (TRE). Designed, coded, integrated, and successfully deployed TRE Software Release 10.0 and analyzed, coded, and certified two new releases. Began the analysis and coding of Software Trouble Reports (STRs) for follow-on releases; supported Battle Group Information Exchange System (IXS).

**Communications Support Technologies.** Provided mechanical engineering design and technical support in the fabrication of automatic test equipment systems and installation support; developed manufacturing technology projects to include Pathways for Continuous Improvement and other industrial base initiatives for joint work with the Army, the Air Force, and the Defense Logistics Agency.

**Consolidated Fleet Submarine Broadcast.** Updated plan; developed planning documentation for WAN.

**CSS/JMCIS Action Team (CAT).** Developed and deployed the first implementation of the Advanced Digital Network System (ADNS) with USS *Kitty Hawk* (CV 63) Battlegroup.

**DARPA MIMIC Technology.** Completed the transition of DARPA MIMIC technology into highly advanced processes and materials under the CEC T/R Module ManTech program that achieved a cost reduction of 33 percent of the major cost drivers for communications and radar phased arrays. A startup contract for ManTech process development of Common All Optical Towed Arrays was awarded. This ManTech project directly impacts three major SPAWAR and Naval Sea Systems Command (NAV-

SEA) ASW systems by transitioning new surveillance technology in parallel with technical base developments in addition to providing significant cost reduction of the acquisition program to follow.

**Data Link Communications System (DLCS).** AN/USQ-125 TEMPALT: Developed, submitted, and received approval for a TEMPALT package to install the AN/USQ-125 Data Terminal on a 688 class SSN. The AN/USQ-125 is a VME-based data terminal that is being considered as replacement for the AN/USQ-76(V)3. CSIC Support: NRaD provides on-site support during the Combat System Interoperability Certification (CSIC) for all new construction SSN 688 class hulls. The CSIC is a two-phase test performed both in port and at sea. A representative from NRaD has assisted with the extensive testing and checkout of the DLCS of every SSN 688 class submarine that has been built. The final CSIC to be performed (USS *Cheyenne* [SSN 773]) is scheduled for July 96.

**E-6B Mission Computer System (MCS).** As a member of the E-6B Command Post Modification Program MCS Integrated Product Team (IPT), NRaD successfully assisted the MCS industry partner during the development of message processing software using concepts from the NRaD-developed MILSTAR Message Processing System (MMPS) software. Also provided key inputs in the area of transmit and receive Emergency Action Message (EAM) processing for the MCS System Specification, Software Requirements Specification (SRS), Interface Requirements Specification (IRS), and Software Formal Qualification Test Procedures (SFQT).

**EHF SATCOM.** Provided system engineering support to SPAWAR and provided support for Joint Warrior Interoperability Demonstration (JWID)-95 from the Navy EHF SATCOM Program (NESP) Land-Based Test Facility.

**Electromagnetics Technologies.** Transitioned the temperature-insensitive, diode-pumped, solid-state laser technology developed under the Applied Physics ONR Program to NAVAIR for its ATD-111 Program. This new technology allows diode-pumped, solid-state lasers to be efficiently used in military environments.

**Enhanced VERDIN System (EVS).** Completed software and system support for upgrades to the software systems of all platforms. The

Enhanced VERDIN system is the VLF/LF receive terminal for the majority of the submarine and associated support platforms, and is the transmit terminal for the airborne relay (TACAMO) platforms. Deployed Software Version 7.7 to airborne and shipboard platforms. This major revision added an automatic mode recognition feature that allows reception of all single-channel Strategic Connectivity System very low-frequency modes without operator intervention. This new capability was vital to the operational use of the high-data-rate communications mode.

**Fail-Safe Insulator.** Under the FVLF Systems Engineering effort, successfully designed a new fail-safe insulator and associated grading rings to replace the aging insulators currently in operation at Cutler. The new insulators, to be installed later this year, have the same voltage rating as the older insulators but weigh approximately 75% less.

**Global Positioning System (GPS) Guidance Package (GGP).** Designed, developed, fabricated, tested, and demonstrated a tightly coupled, miniature, integrated navigation package including solid-state rotation sensors and accelerometers to perform low-cost, high-performance vehicle navigation (strike weapons, high-performance aircraft, and unmanned vehicles [UMVs]).

**High Data Rate (HIDAR).** Successfully deployed the HIDAR communications mode in the Enhanced VERDIN System software. Supported the successful test and evaluation of HIDAR, which led to it becoming an operational Strategic Communications System (SCS) mode.

**High-Data-Rate Communications.** Developed a simulation capability to determine channel capacity under various operational conditions. Initial results were reported at the Military Communications (MILCOM) 95 conference in November. The performance of narrowband adaptive interference suppression filters initially reported for one class of filters is being extended to a broader class of filters with modifications to include the effects of mobile transmitters and receivers. Updated the high-data-rate communications mode documentation to support the implementation of the system in the Modified Miniature Receive Terminal. This pro-

gram also certified and fielded several upgrades to Submarine Communications including the following: the Integrated Radio Room (IRR) (for receiving submarine-launched ballistic missile retargeting messages), integration of ELF, upgrading the IRR message processor, and effecting crossover to KG-84s.

**Hyperspectral Mine Detection.** Successfully completed several field experiments to establish the phenomenology of Hyperspectral Mine Detection at Fallon NAS, the Nevada Test Site; in Hawaii; and at Ft. Huachuca. Lawrence Livermore National Laboratory fielded its Livermore Imaging Fourier Transform Infrared Spectrometer for the desert experiments. Design work for a new miniature, ruggedized airborne spectrometer was begun. Algorithm development for data processing/reduction continued. Contracts were awarded to the University of Hawaii, Technical Research Associates, Space Computer Corporation, Sensor Concepts Applications, and Space Applications Corporation.

**Information Security Systems/Architecture.** Planned and executed the transfer of software support responsibility and capability for the AN/USC-43(V) digital voice terminal to NRaD. Tested and delivered upgraded software and support documentation for the Navy Automated COMSEC Reporting System to more than 1100 Navy, Marine Corps, and Coast Guard customers. Established a "Help Desk" to assist fleet users and system operators with responsive software assistance. The program also executed the transfer of software support responsibility and capability for the Navy Key Management System to NRaD, established software development and test environments, and stood-up defect control and configuration management systems.

**Information Systems Engineering.** Made design upgrades, including fiber-optic technology, to the Data Multiplex System on the DDG 51, resulting in data transfer improvements.

**Integrated Submarine Automated Broadcast Processing System (ISABPS)—Phased Improvement Program (PIP) Software Release 9.** Developed and deployed Release 9.2 and 9.3.2.

Release 9.2 ported AN/UYK-20 software to the AN/UYK-83. The AN/UYK-83 software was developed in Ada and hosted in (COTS) real-time UNIX, which hosts a multitasking environment for online control of equipment switching and IVTT software. The IVTT software coupled with the AN/URT-30B performs signal processing allowing complete replacement of the FVLF/LF VERDIN Transmit System, AN/URT-30. Release 9.3 provided the Fleet with the capability for broadcast backload operations from ISABPS to SSIXS. This broadcast backload operation allows any connected SSIXS to recover FVLF broadcasts data from any connected ISABPS.

**Integrated Submarine Broadcast Processing System Update.** Deployed to 8 of the 10 operation sites. Software and fleet documentation for several associated systems were also approved, deployed, and installed.

**Integrated VERDIN Transmit Terminal (IVTT).** Designed and developed VERDIN Transmit hardware and software that allowed complete replacement of the obsolete AN/URT-30s or at fixed sites. The IVTT Software version 1.1 was the first version deployed. Since deployment, operator enhancements and dual crypto operation have been made. Designed, built, and tested 30 production units of the AN/URT-30B VLF/LF Transmit System. This includes the MT-6888 Electrical Enclosure Shelf, the EVS Control Unit, and the NRL-designed MT-1310 Modulator. Also completed were the First Article Qualification Test and Acceptance Test Reports. The AN/URT-30B units were deployed in conjunction with ISABPS PIP REV F installation.

**Interior Shipboard Communications.** Incorporated the Interior Communications (IC) backbone specification into LPD 17 ship specification; incorporated a multilevel security (MLS) prototype of the backbone in the NRaD lab; began testing and characterization.

**LF Navigation.** Under the FVLF Systems Engineering effort, successfully completed a concept formulation study to use transmissions from the Navy's FVLF stations and a modified Litton LTN-211 receiver to replace Omega for SSNs operating under the polar ice cap in the Arctic.

**Local-Area Networks/Wide-Area Networks.** Developed World Wide Web technology implementation strategies and a model home page prototype to standardize and facilitate sharing of information among labs.

**Mobile Communications Technologies.** Participated in working groups and planning for Global Broadcast System (GBS) development; assessed the applicability of the existing modems and radios to high-data-rate initiatives for UHF and Ku/Ka band systems.

**Modeling and Simulation.** Performed modeling to analyze Navy Theater Ballistic Missile Defense (TBMD) information architectures and evaluate data requirements for architecture functional activities. Models that had been developed for characterizing current Navy AAW operations were adapted for this effort. Analyses included allocating processes to systems and determining adequacy of systems/platform connectivities to meet the data requirements for the processes. Several technical papers were prepared describing "as is" and "to be" physical architectures and their relationships to information transfer and processing requirements.

**Modified Miniature Receive Terminal (MMRT).** Provided system engineering and software engineering to the U.S. Air Force for the implementation and integration of HIDAR with adaptive signal processing, Signal Separator, and Non-linear Adaptive Processor (NONAP), into the MMRT multichannel scanning receiver.

**Multifunction Electromagnetic Radiating System (MERS).** Developed MERS concept. Under the ONR exploratory development program, a MERS concept has been developed in which the RF transmission and antenna requirements of four different radiating systems will be merged into a single transmission and antenna structure. An advanced technology demonstration (ATD) based on this MERS concept has been proposed and has been selected for start in FY 97. The proposed MERS ATD will demonstrate, at sea, a merged, low-cost antenna system that will restore full combat system performance for multiple systems, reduce sensor signature, meet the demands of a real shipboard environment, and decrease topside weight, moment, and volume.

**Multiple Platform Links.** Supported the HF Defense Communication System (DCS) entry upgrade for the Defense Information Systems Agency (DISA); prepared a draft procedure for the Communications Exercise (COMEX) document. This draft procedure was tested during a full-up over-the-air test between an AN/TSC-120 HF communications shelter at Camp Pendleton, CA, and McClellan AFB, CA. Test messages were sent directly into the Automated Digital Information Network (AUTODIN) system.

**NATO Interoperable Submarine Broadcast System (NISBS).** Successfully developed several software upgrades. These upgrades have completed formal testing and are awaiting hardware upgrades to facilitate deployment. NISBS Software Release 3.1, deployed October 1994, implemented the standard configuration of software that supports NATO STANAG 5030 Modes N2, N3, N4, N5, and N6 with up to two modulator outputs. NISBS Software Release 3.2, deployed FY 95, added the synchronization of formatter clock to FTS and enhanced the remote circuit configuration to include the four-channel broadcast pass-through mode. NISBS Software Release 3.3, currently in process of deployment at Nisemi, Italy, adds the capability to access the formatter remotely for status and error logs. These remote access logs accumulate information over a 30-day period.

**Navy EHF Communications Controller (NECC).** Participated in the Communication Support System demonstration involving USS *Kitty Hawk* (CV 63), USS *Cowpens* (CG 63), and NCTAMS EASTPAC. This demonstration provided successful transfer of tactical data via an IP router over multiple media, using the NECC for the EHF portion. The NECC software was also approved for release to the Fleet for operational use.

**Network Technologies.** Developed routing metrics to predict the effect of adding new connections to an ATM network.

**Non-linear Quasi-Phase Matched (QPM).** Designed and fabricated devices consisting of diffusion-bonded stacks of alternating layers of indium phosphide. Transmission losses of ~1% per interface were achieved.

**NRaD Coverage Prediction Program.** Completed the development and testing of the Submarine Communications Assessment Tool Software; delivered to operational forces in FY 95.

**Range Extension Modes (REMs).** The REMs are being developed to provide the Navy with greater coverage and throughput for VLF/LF communications. REM will replace current Navy (VERDIN) communications modes. Simulation software is being developed to test the new message compression and Error Detection and Correction (EDAC) technologies that comprise REM. The REM design involves substantial reuse of HIDAR technology. Prototype REM will be developed in FY 96/97. The requirements were presented at a design review and are currently under fleet review.

**RF Networks.** Formed the Communication Support System (CSS)/JMCIS Action Team (CATS) to direct development and field initial CSS capability.

**RN Submarine Satellite Information Exchange System (SSIXS).** Completed development of RN SSIXS, which included test and integration of Screening-on-the-Fly satellite link protocol required for interoperability with U.S. SSIXS.

**SATCOM Tests with the Predator Unmanned Airborne Vehicle (UAV).** Conducted and coordinated tests to access UHF Fleet Satellite assets. Alternative communication links were proposed for the Hunter UAV to use the Light Airborne Multi-Purpose System (LAMPS) or Common High-Bandwidth Data Link systems. Improved shipboard C3 integration to the Joint Maritime Command Information System for the Pioneer UAV was proposed. A communication relay development for the Hunter UAV was supported. Planning was conducted for a UAV/cruise missile demonstration using SHF SATCOM to provide imagery to an afloat platform.

**Satellite Communications Support.** Provided software support to SPAWAR and the Fleet. Made successful installations of Local Operations Control Center (LOCC) versions 18.3 and 18.31, and Antenna Control Unit (ACU) for 7-foot antenna installations. Successfully introduced software that minimized antenna hand-over effects.



**Sensor Fusion Experiment.** Successfully conducted experiment at the Innovative Science and Technology Experimentation Facility (ISTEF) involving microwave radar, several passive optical sensors in the 3- to 5-micron region, and laser radar. Simultaneous data from these various sensors were recorded using free-falling targets containing GPS.

**SHF SATCOM.** Updated the SHF portion of the System Specification; conducted 7-foot antenna mounting stiffness requirements study and developed 7-foot antenna mounting and flexure papers. The team also completed an AN/WSC-6(V)XX proposal evaluation and participated in specification and statement-of-work efforts. Updated the "Future PH-III Navy SHF SATCOM System" functional description.

**Signal Processing.** Prepared a Program Plan and a draft High Systems Requirements document for the Communications Super Chip.

**Single Channel Ground/Air Radio System (SINCGARS).** Built Numerical Electronic Code Models and ran computer EM databases to design and determine performance criteria. LSD 41 and LHD 1 requirements call for installations of VHF signal-hopping radios called SINCGARS. The new shipboard systems require an integrated analysis to meet shipboard performance criteria and operational requirements.

**Soldier 911 Program.** Under DARPA sponsorship, this project started the Soldier 911 Program to support the Seventh Army's border patrols along the Macedonia-Serbia border. During FY 95, the system became operational in Macedonia. In January 1995 after the downed helicopter incident in Korea in late 1994, a Phase I version of the Korea Soldier 911 system was deployed and demonstrated in February 1995. DARPA integrated a PRC 112 radio, radio interface, communication network, and DARPA GPS receiver chip into a single handheld package.

**Stochastic Target Detection and Recognition (STD/R) Project.** Developed adaptive filtering techniques using two-dimensional least mean square (LMS) noise-canceling to exploit the differences in signatures between the natural background and manmade objects. A field experiment was conducted at NRaD using the Specially Modulated

Imaging Fourier Transform Spectrometer (SMIFTS) hyperspectral infrared sensor to obtain vehicle target signatures.

**SUBCOMM Technology.** Updated systems and software to provide an avenue to include PC-based receivers as hosts using government off-the-shelf (GOTS) standard software.

**Submarine Communications Assessment Tool (SCAT).** Using the VLF Long Wave propagation prediction model developed earlier and a Pentium PC, NRaD developed the SCAT. This equipment is in use by both COMSUBLANT and COMSUBPAC to make VLF coverage predictions, enabling better movement management of their deployed submarines.

**Submarine Communications Support System (SCSS).** Developed the Architecture Description Document that defined the SCSS goal architecture. Assessed commercial SATCOM products and radio equipment for use in radio rooms. Provided support to the new attack submarine, baseband switch, and SCSS security design for future submarine programs. Supported the merger of the SCSS into the JMCIS environment.

**Submarine Low Frequency (LF)/Very Low Frequency (VLF) VMEbus Receiver (SLVR).** Provided requirements analysis and preliminary design phases. The SLVR is the next generation of VLF/LF receive terminals for all submarines. Completed the preliminary and detailed design phases of SLVR development. This effort resulted in a design that uses commercial off-the-shelf components for nearly 90% of the hardware. In addition to the reliance on commercial VMEbus components, the software will include substantial reuse of government software.

**Submarine Message Buffer (SMB).** Integrated SMB with the NECC and Baseband Switch projects, a first step toward demonstrating the Submarine Communications Support System future radio room concept. Successfully established and maintained the new Software Support Activity to support configuration management and quality assurance.

**Switching.** Developed a high-speed data switch (HSDS) to interconnect Navy computers and peripherals in support of the AEGIS program at the Naval Surface Warfare Center (NSWC).



**System Engineering.** Provided system engineering covering a wide range of systems, including the TRIDENT SCSS variant, High Data Rate (HIDAR) for TRIDENT, post shakedown availability for SSBN, and UHF power amplifier failure. This effort also required software changes and engineering and document upgrades for the MILSTAR Message Processing System.

**TACAMO Message Processing System (TMPS).** Developed software updates in anticipation of January 1996 baseline. NRaD made and installed several software changes to the system that included improvements in the efficiency for the Enhanced VERDIN System to the TMPS interface and incorporation of new message formats. Delivered Software Release 10.0 to NAVAIR Software IV&V Activity and received recommendation for deployment to the Fleet. Release 10.0 is scheduled for deployment in late FY 1996. This Software Upgrade implements a more efficient interface to the EVS transmit system, implements updates for the processing of UHF Air Force Satellite Communications (AFSATCOM) Emergency Action Messages (EAMs), and is compatible with new and updated EAM message formats as defined in Commander Joint Chiefs of Staff (CJCS) Emergency Action Procedure (EAP) Volume VII.

**Terrestrial Communications Links.** Performed developmental testing of both low-rate data and high-rate data high-frequency radio telemetry and control circuits for the Remote Minehunter System. Sufficient hardware to outfit a prototype minehunter vehicle was provided and spares purchased. An over-the-air test demonstrated 56 kbps over HF over a distance of 65 miles. Candidate antenna systems were considered and full-scale impedance measurements were completed. HF e-mail software was revised to increase overall system speed. New interface cards were designed, tested, and fabricated for full RS-232 interface operational. A live over-the-air demonstration was conducted in the Pentagon (Aug 95).

**Three-Mode Scanning.** Developed a three-mode scanning approach for HIDAR implementation in the Enhanced VERDIN system and supported this implementation. On-the-air simultaneous operation was suc-

cessfully demonstrated aboard TACAMO aircraft operating in distant areas.

**Time and Frequency Distribution System (TFDS).** Successfully demonstrated TFDS Proof-of-Concept using a system acquired, and currently in operation, in the Submarine Communications PITCO facility. Supported successful TECHEVAL, Functional, at NRaD, and Performance, in the Land-Based Submarine Radio Room at NUWC. A production contract is planned for FY 97.

**TRIDENT Direct Fleet Support.** Successfully responded to three requests for Direct Fleet Support by Commander, Submarine Squadron 20, at Submarine Base, Kings Bay, GA. Accomplished the upgrade to the radio room of USS *Rhode Island* (SSBN 740), prior to deployment on sea trials. With the concurrence and support of the Strategic Systems Program Office (SSPO), NRaD implemented Submerged Launch Ballistic Missile (SLBM) retargeting prior to weapons qualification tests. Conducted failure analyses of the UHF/PA and AN/WSC-3(V)12/18 transceivers.

**TRIDENT Integrated Radio Room (IRR).** Transitioned four Land-Based Evaluation Facility on-site representative positions from SPAWAR to NRaD. This team, augmented by the NRaD San Diego project office, certified the final three shipsets of the Integrated Radio Room (IRR). The final shipset will depart Newport for Superintendent of Shipbuilding, Groton, in June 1996.

**TRIDENT Integrated Radio Room (IRR) Upgrades.** Deployed a new firmware release for TRIDENT that resolved five Submarine Satellite Information Exchange System (SSIXS) problems unique to the IRR. Deployment of the EVS upgrade that implemented HIDAR was smoothly accomplished in all TRIDENT hulls. Conducted eight EHF Working Group meetings culminating in a smooth EHF change package approved by all parties—shipbuilder, NAVSEA, SPAWAR, etc.

**UHF SATCOM.** Provided technical information and participated in the development of the field change kit for the TD-1271s so DAMA UHF SATCOM channels may operate in the automatic mode. This was the

lead technical Integrated Product Team (IPT) in developing system requirements and performance specification. The project also provided support to JWID-95 from the Navy UHF System Test Facility.

**VERDIN.** Supported system engineering activities. NRaD provided support in analyzing U.K./NATO STANAG 5030 incompatibilities. The VERDIN Multiple MTU loader was upgraded and VERDIN Engineering support was provided for implementing the IVTT dual crypto operation and improved RADAY procedures. Also, fabrication and certification of 11 Multi-Link Transmit Simulator (MLTS) Mod 1 units were completed. These units replace VDTS units that are no longer supportable.

**VERDIN Transmit Terminal.** Implemented changes allowing elimination of a requirement for specialized software for the VERDIN transmit terminal as a part of a phased improvement to replace old equipment.

## SURVEILLANCE

**Acoustic Sources.** Conducted demonstration of the Thermal Air Gun at Lake Seneca; completed characterization of Third-Generation Electrostrictive Ceramic (PMN-PT); evaluated characteristics of High-Strain Phase Change Ceramic (PLSZT); upgraded Hybrid Projector Electronics; and hosted Transducer Technology Workshop.

**Advanced (COMINT) Voice Processing ATD.** Obtained technical information.

**Advanced Deployable System (ADS).** Completed evaluation of contractor proposals and supported protest review; conducted several major at-sea data collection exercises; developed and implemented several management tools; developed risk reduction plans to assist hardware developments; participated in all IPTs employed to support and manage ADS development; supported the development of the All-Optical Deployment System (AODS).

**Advanced Sensor Applications Program (ASAP).** Established a contract for the development of an airborne light detection and ranging (LDAR) system; evaluated the application of coherent laser radar (CLR) for periscope detection, identification, and tracking; performed periscope optical signature measurements; and investigated the performance of hyperspectral imaging sensor performance.

**Automated Track-Before-Detect Processing.** Developed and refined track-before-detect processing and evaluated with ADS datasets.

**Autonomous Sensor Concepts Project.** Wrote project plan for new start in FY 96.

**Bottom Limited Active Classification (BLAC).** Implemented test bed for Surveillance Towed-Array Sensor System (SURTASS)/LFA detection and classification processing in an HPC environment. Demonstrated enhanced detection with a novel active sonar adaptive beamformer implemented in a system context.

**CERCIS.** Provided technical support and system upgrades.

**Common Aperture Multi-Band Radar (CAMBR).** Awarded contract to design and build a proof-of-concept transmitter, receiver, signal processing algorithms, and equipment required to demonstrate CAMBR performance.

**Common Integrated Platform.** Developed an interoperable software platform that is both scalable and transportable to a wide variety of computers, proving that "plug-and-play" is a viable concept for future tactical systems. The integration is based on the Common Object Request Broker Architecture (CORBA) and uses commercial object-oriented software. Initial proof of concept is scheduled for late Calendar Year 96.

**dbMASTER.** Distributed a maintenance release of dbMASTER v2.0(r2) that included updates to the intelligence databases and hard copy reference documents. Released dbMASTER v2.1, which provided enhancements to the digital maps and methods for querying the Electronic Parameters List (EPL). dbMASTER is being integrated into the

U.S. Army ASPO systems and is currently in the Air Force Combat Intelligence System (CIS).

**Deployable Autonomous Distributed System (DADS).** Improved the FCDS target classification algorithm by incorporating electromagnetic sensor information with existing acoustic parameters in the target database and by updating the associated fuzzy logic rules in the algorithm. A system modeling and simulation approach was defined. The network optimization model for controlling acoustic communications in the distributed field was formulated.

**Distributed Surveillance Technology.** Completed operation and recovery of the Shallow-Water Sensor System, which integrated and demonstrated several of the projects' developments; demonstrated long-term (6 months) operation of pressure-tolerant telemetry in shallow water; demonstrated maximal use of the "slack-line" analog multiplexing scheme for acoustic sensors; completed the design for a "pop-up" RF communication buoy; completed the design for a high-speed (2.5 Mb/s per channel) RF data link; demonstrated three-channel bidirectional fiber-optic multiplexing using low-loss Polarization-Independent Narrow-Channel (PINC) Wavelength Division Multiplexors (WDMs); completed design and parts procurement for an automated fiber-optic manufacturing suite; completed the design of a four-channel PINC WDM Add/Drop Filter; completed acquisition of multifunction Acoustic Data Acquisition System devices to support undersea power source development; demonstrated a 175-nm digital communication relay using a NASA solar-powered UAV flying between 22,000 and 50,000 feet.

**Electromagnetic Field.** Completed at-sea testing of an electro-optically based electromagnetic field (EMF) probe designed and built by NRaD. The design goal of the probe is to detect and identify all on-ship EMF emissions, at frequencies ranging from 2 MHz out to 18 GHz. Testing was carried out onboard USS *Chancellorsville* (CG 62), an AEGIS class guided missile cruiser, as it sailed from San Francisco to San Diego. Despite high seas, rain, and strong winds, successful testing of the probe was completed without any problems. Among the shipboard systems

tested were all the major communications bands, navigational radar, electronic warfare systems, and weapons targeting radar.

**Fixed Distributed System (FDS).** Completed the FDS-1 analysis and disseminated the results; established the framework for the FDS-1 7800 Concept of Operations (CONOPS); hosted operational concept working group sessions; published the FDS T&E 7800 CONOPS and Fleet CONOPS; published TECHEVAL Test Plan and TECHEVAL Data Collection and Analysis; worked with Operational Test and Evaluation Force (OPTEVFOR) and trusted agents to incorporate their operational requirements into the Navy Data Collection Plans, Test Plans, and Test Procedures; negotiated Target Services with Commander, Submarine Force, Atlantic Fleet (COMSUBLANT) for FDS System Acceptance Test (SAT); developed extensive scenario tracks and target services requirements that were used to evaluate FDS system performance; and conducted the SAT and published the SAT/IOC Report; completed FDS-1 TECHEVAL and met IOC requirement (final TECHEVAL report in production).

**Flying Plug.** Performed tests of the Flying Plug at the NRaD Transducer Evaluation Center (TRANSDEC). During these tests, man-in-the-loop control was used. Several successful dockings were made, verifying that the hardware additions and modifications implemented since the last tests were successful. When docked, the Plug relayed a 100-Mbps, real-time color television signal over the fiber-optic microcable link.

**Hayfield Multi-Chip Module (MCM).** Completed the Hayfield MCM hardware design and provided it to Sandia for manufacturing. The first Hayfield MCM was delivered to NRaD on 25 August 1995. The MCM was tested in the Hayfield Development Laboratory, and it successfully decrypted the TDDS broadcast data on all four channels.

**High-Frequency Surface Wave Radar (HFSWR) ATD.** Initiated ATD plan. Phase 1 contract awarded to two contractors for study, analysis, and detailed design; transmit and receive antennas were designed and modeled.

**Iceshelf-95.** Concluded Iceshelf-95 arctic field experiment for Project Spinnaker with several major accomplishments. (Project Spinnaker is a joint U.S./Canada project to develop and demonstrate lightweight low-power, low-cost acoustic arrays; the Iceshelf series are Spinnaker field tests and experiments.) The main focus of Iceshelf-95 was on the Canadian Autonomous Undersea Vehicle (AUV) *Thesius*, which successfully completed several critical commissioning tests, including remote navigation, system operation, propulsion, communications, and fault handling. On-ice segments of the experiment using NRaD's cutting-edge array technology verified the U.S. segment of the technology.

**Integrated Undersea Surveillance System (IUSS) Surveillance Direction System (SDS) Shore Systems Engineering.** Underwent FDS TECHEVAL; IOC was declared for the FDS system; installed FDS/SDS Build 5 software release at NRaD in IUSS System Engineering Facility (ISEF); continued prototyping efforts to investigate SDS reengineering using JMCIS functions; continued prototyping of WAN concept of operations for IUSS sites (transferring concept from SunOS to Solaris operating system); conducted Government Factory Acceptance Testing (GFAT) of FDS/SDS Build 5 software prior to installation at Special Project Site. The SDS Communications Node Controller (CNC) is scheduled for first quarter 1997.

**Marine Mammal Acoustic Tracking System (MMATS).** Successfully completed the third and final MMATS flight of the ONR "Tracking Humpback Whales with IUSS" exercise. This mission used MMATS to search an area over 400 nautical miles north of Hawaii for a humpback whale that had previously been tagged with an ARGOS satellite tag. MMATS has been used to support a variety of U.S. Navy tests involving the use of explosives and/or the transmission of high-level acoustic signals.

**Low Earth Orbit (LEO) System Program Office (SPO) Support.** Assessed critical algorithms and identified bottlenecks/saturation points; suggested alternative architectures with greater parallelization potential; tested major tactical receivers in the NRaD Joint Space and Tactical Sys-

tem Division's RF lab. Several previously undetected design flaws were identified.

**Mine-Laying Surveillance.** Successfully completed a series of mine drops from a small surface platform off the coast of Camp Pendleton. The experiment obtained data regarding the feasibility of detecting mining operations in a near-shore environment similar to what might be expected within an amphibious operating area. The data will be used for further definition of autonomous sensor systems to support expeditionary and littoral warfare.

**Mobile In-shore Undersea Warfare System Upgrade (MIUW-SU).** Delivered a Mobile Sensor Platform (MSP) to In-shore Undersea Warfare Group 1. This is the second MSP delivered to the Fleet. Van number 1 was integrated and tested. The first article Small Boat Deployment System (SBDS) was built and tested.

**Multistatic Active Project.** Conducted major shallow-water sea test that demonstrated detection performance against a diesel-electric submarine; submitted three publications documenting advanced adaptive processing for reverberation suppression.

**Non-Acoustic Distributed Systems Components (NDSC).** Demonstrated real-time fire control quality tracking; demonstrated single sensor detection and tracking; demonstrated classification using electromagnetic signals; demonstrated separation of surface ships and submarines in shallow water; extended detection range using transient signals; and participated in major at-sea data collection exercise.

**Radiant Jade.** Demonstrated the near-real-time transmission of Electronic Order of Battle (EOB) information over the TRAP Data Dissemination System (TDDS) and the reception of the data by JEAP/Sunshine systems at various sites. Radiant Jade I proved the concept in the Pacific area (seven sites); Radiant Jade II included the aircraft carrier USS *Abraham Lincoln* (CVN 72); and Radiant Jade III successfully brought EOM update information to over 20 multiservice users in Europe, the United States, and Asia, using data provided by such organizations as JICPAC, STRATJIC, and JAC Molesworth.

**Rapid Imagery Transmission (RIT).** Completed Phase 1 of RIT to modify the MATRIX system to facilitate imagery analyst generation of contact reporting; completed Phase 2 planning, which refines TDDS reporting formats and develops tactical receiver software and concept of operations.

**Relocatable Over-the-Horizon Radar (ROTHR) (AN/TPS-71).** Certified the ROTHR-Texas production system for joint surveillance operations in June 1995. Conducted testing, analysis, and evaluation of a Block Upgrade to mission software to support Multiple ROTHR Track Data Fusion (MRTDF). This enhancement supports single track reporting of contacts detected in overlapping coverage regions by more than one AN/TPS-71 system. Supported NISE East and Rome Laboratories with testing methodologies and analysis of proposed ROTHR enhancements. For those enhancements that were transitioned to the AN/TPS-71, conducted laboratory and field testing, as well as analysis to evaluate whether or not the contractor met the performance specifications for Tracker Modifications, Impulsive Noise Excision, and Enhanced Range Capability. Modified the production contract to execute the proposed Puerto Rican installation, integration, and acceptance testing for production system 3.

**Robust Environmentally Based Adaptive Broadband Beamforming.** Continued development and validation of robust adaptive matched field beamformer using vertical line array (VLA) data from Strategic Air Command, Atlantic (SACLANT) and Shallow-Water Environmental Cell Experiment (SWELLEX) experiments.

**SWELLEX-4.** Accomplished SWELLEX-4 experimental objectives. The joint experiment between NRaD, the Marine Physical Laboratory (MPL) at Scripps Institution of Oceanography, the Naval Research Laboratory (NRL), and Defence Research Establishment Atlantic (DREA) (Canada) continued the SWELLEX series of experiments to increase Navy understanding of acoustic surveillance issues in the littoral region by conducting carefully designed ocean acoustic experiments in the waters off Southern California, with precisely measured ocean environmental conditions and strong baseline "truth" parameters.

**Shallow-Water Sensor System (SWSS).** The SWSS-1, deployed off Point Loma in June 1994, was successfully recovered from its location approximately 6 nmi off the coast after being in the water for 10 months. An alternate power supply and RF communication link is being developed for the system, which will eliminate the need for the shore cable.

**Shipboard Infrared Search and Track.** Demonstrated multiprocessor algorithm suite including image processing, target detection, and tracking; modified contract to include near-real-time multiple hypothesis tracker.

**Spatial Processing for Deployables.** Demonstrated signal coherence and detection of a target-of-opportunity between two widely separated horizontal line arrays (HLAs) in the Straits of Gibraltar.

**Submarine ESM Systems.** Developed and began implementing engineering changes to the AN/BRD-7 system. Completed development and initiated procurement of high-probability-of-intercept (HPI) receiver subsystem for the AN/WLR-7 system. Awarded contract for procurement of the AN-WCQ-4(V) ESM system for the SSN 23 submarine.

**Surveillance Towed-Array Sensor System (SURTASS) and Low-Frequency Active (LFA).** Conducted LFA 13 and Project M At-Sea Tests; supported fleet operations with *Cory Chouest*; completed LFA Employment Guide; completed Low-Frequency-Active Transmit Subsystems (LTS) Operational Guidelines for *Cory Chouest* Operations; characterized aging effects on LTS array; submitted Magellan II Final Report; generated single- and twin-line signal-to-noise ratio and noise comparisons.

**Surveillance All-Optical Towed Array (SAOTA) Program.** Completed design of fiber-optic hydrophones, tow cable, connectors, electronic circuit boards, and other components critical to the development of an all-optical array.

**Tactical Cryptologic Systems.** Developed and certified Cryptologic Unified Build (CUB) Release 2.2.1. Supported planned upgrade of OUTFBOARD incorporating enhanced direction finding (DF) capability,



Navy-standard Tac-3 computers, and CUB software. Developed CUB software segments for Battle Group Passive Horizon Extension (BGPHEs), Combat DF, and Ship Signal Exploitation Equipment (SSEE) systems.

**Tomahawk In-flight Position Reporting System (TIPRS).** Completed successful operational flight demonstration of TIPRS; completed two production Tomahawk Receiver Units (TRUs).

**TRAP Data Dissemination System (TDDS).** Completed design development of the TDDS Upgrade 6.0, being developed to replace the current TDDS Processor with hardware and software that will meet the requirements of a centralized TDDS network. Software testing started in May 96, and will continue through September 96. Shipment is scheduled for October 96 with FOC planned for December 96.

**USS *Dolphin*.** Performed Qualification Corrosion Testing of High-Alloy Fasteners for the *Sea Wolf*/NAS program. Provided instrumented target services for Mk 50 Torpedo Shallow-Water Testing (Southern California [SOCAL] and Pacific Northwest [PACNORWEST]); provided baseline target field surveys for T&E of EC 17 upgrades to BQS-15 submarine sonar systems; demonstrated HF e-mail using COTS Automatic Link Establishment Transceivers beyond 1000 miles during deployment to PACNORWEST.

**Vertical Launch ASROC (VLA):** Supported production of U.S. and Japanese FMS units; provided fire control training and test data analysis for JDS KARISHIMA CSQT; completed USS *Curtis Wilbur* (DDG 54) DT/OT test report; completed JDS KONGO test report; developed spreadsheet for summarizing VLA flight accuracies; developed VLA flight database; began development of a program to process SPY radar data to track missile flights; modified telemetry retrieval program from VAX to PC platform; and conducted Service Life Extension Program (SLEP) planning.

**Virtual Lab.** Established circuits for the wide-area network; established and accredited computer networks; installed and checked out software for white boarding and video teleconferencing (VTC).

**Hidden Markov Model (HMM)/Neural Net (NN) Classifier.** Completed the theoretical development of the hybrid HMM/NN classifier; preliminary hybrid classifier design, preliminary testing of classifier, journal article, and final report.

## COMMAND, CONTROL, AND COMMUNICATION MODELING AND ANALYSIS

**Kernel Blitz 95 (KB95) Sub-System Integration Test (SSIT).** Conducted Kernel Blitz 95 SSIT. This event was designed to test interactions of Distributed Interactive Simulation (DIS) protocol entities generated by the KB95 simulation sites over the Defense Simulation Internet (DSI). Entities were generated by Naval Undersea Warfare Center (NUWC), Newport, RI; Naval Air Warfare Center-Aircraft Division (NAWC-AD), Patuxent River, MD; FCTCLANT, Dam Neck, VA; and WISSARD Lab, NAS Oceana, VA. Johns Hopkins University Applied Physics Laboratory (APL) Warfare Analysis Laboratory (WAL) participated as a DSI Viewport. Testing was controlled from NRaD. A successful digital voice communications test was also conducted between NRaD and NAWC-AD during the SSIT.

**Marine Air Ground Task Force (MAGTF) Tactical Warfare Simulation (MTWS).** Approved for service use by the Commanding General, Marine Corps Systems Command. MTWS was fielded at four sites: First Marine Expeditionary Force (MEF), Camp Pendleton; Second MEF, Camp Lejeune; Third MEF, Okinawa, Japan; and the Marine Corps Combat Development Center, Quantico, Virginia. MTWS is now the primary combat simulation for use in computer-assisted exercises that involve Marine forces. MTWS can support a MEF-level exercise with ground units modeled at the company level including a full range of command and control capabilities for all phases of combat operations. MTWS successfully completed Aggregate Level Simulation Protocol



(ALSP) testing for use in joint service modeling and simulation configuration exercises.

**Research, Evaluation, and Systems Analysis (RESA).** Participated in the ULCHI FOCUS LENS exercise in the Republic of Korea. The foreign military sale (FMS) of RESA to the Republic of Korea (ROK) was finalized. NRaD will perform RESA installation and training for the ROK.

**STOW Engineering Demonstration #1.** Successfully completed the integration of Army, Navy, Marine Corps, and Air Force Synthetic Forces with dynamic Synthetic Environmental Effects using the advanced technologies of Real-Time Information Transfer and Networking. Integrated the first behavior representation of command decision making in the Synthetic Forces technology area in the new Command Forces area. Real-Time Information Transfer and Networking incorporated dynamic multicast for the first time.

**Synthetic Theater of War-Europe (STOW-E).** Successfully completed SSIT No. 8 at approximately 15 sites. During the first 2 days, the Defense Simulation Internet (DSI) had zero percent reliability/availability; the last 2 days were near 100-percent reliability/availability.

## NAVIGATION

**Air Navigation.** Completed formal qualification testing of the Control Display Navigation Unit (CDNU) operational flight program for the CH-46 and CH-53 aircraft. The CH-46 has since successfully completed TECHEVAL. Initiated development of the CDNU modification for the EA-6B and the F-14A/B software. For the KC-130, CH-53, CH-46, and UH-1N, NRaD is developing a CDNU software operational training program. Completed integration of ARC-210 VHF/UHF radio control software into CDNU. This software is now flying in United States Marine Corps (USMC) KC-130 aircraft. Finished installation of GPS into HC-130 aircraft. Successfully completed Development Testing and Operational Testing with the Coast Guard.

**Common RLG N Navigator.** Successfully completed the Common RLG N Navigator competitive procurement process on schedule by NAVSEA with significant NRaD technical support. The contract was awarded to Sperry Marine Systems. The development program involves configuring RLG N systems to meet surface ship and submarine requirements, testing the systems, and conducting DT and OT in the Fleet.

**Global Positioning System (GPS).** GPS Inertial Navigation Assembly (GINA) successfully completed laboratory performance verification tests on Low Rate Initial Production (LRIP) units in support of T-45 Developmental Test/Operational Test (DT/OT) program requirements. Embedded GPS Inertial (EGI) successfully completed Qualification Testing. Demonstrated and tested the Simulated Inertial and GPS integrated Simulation Capability. Completed a series of accuracy and integrity tests in support of the FAA CATIIB Feasibility Study. The task required an enhancement of the accuracy of NRaD's GPS signal simulators to the centimeter level. In addition, special scenarios were developed to simulate an aircraft landing under a variety of anomalous conditions such as multipath, various satellite geometries, and environments under which alarm conditions would be expected. Twenty-eight different scenarios were imposed on the systems. An automated system of data reduction was developed to expedite the analysis. The ability to impose these controlled environments and to measure navigation accuracy with such precision cannot be achieved with flight testing.

**Navigation Sensor System Interface (NAVSSI).** Successfully completed the development of the initial version of the NAVSSI product line, namely Block 0 and introduced it into the Fleet aboard cruisers and destroyers. Through an evolutionary acquisition process, the Block 2 development was initiated and will have significantly expanded capability to support a broader class of ships, including carriers, LHA's, frigates, cruisers, and destroyers. Block 2 will be a dual redundant system for combat survivability and will host the next-generation GPS.

**Navigation Technology Programs.** Completed the development of a marine navigation quality Fiber-Optic Gyro (FOG) under the ONR 6.2 Navigation Block Program. This FOG has been transitioned to the NAVSEA Navigation System Acquisition Manager and is available for use in

the next generation of marine gyrocompasses. Results of this FOG development have also provided the basis for the new FY 96 High-Accuracy FOG Program being conducted by NRaD under the ONR 6.2 Navigation Program.

**Ocean Survey Program (OSP).** Developed and successfully integrated and conducted an at-sea demonstration of equipment and software designed to demonstrate improved Mk 86 gunfire accuracy by using GPS navigation data. Successfully conducted final Technical Evaluation of an integrated navigation processing system (NPS) aboard the NAVOCEANO survey ship, USNS *Kane*. Successfully conducted dockside and at-sea technical evaluation upgrades to the multimission survey system aboard the NAVOCEANO survey ship, USNS *Silas Bent*. Successfully completed the design, development, field test and evaluation, and delivery to NAVOCEANO of 18 production type Differential GPS Data Link Systems. These portable, field-deployable units are used by NAVOCEANO for hydrographic surveys carried out in 22 undeveloped nations under the Hydrographic Cooperative Program (HYCOOP). Successfully completed the integration, test and evaluation of upgrades to the multimission survey system aboard the newest NAVOCEANO survey ship, USNS *John McDonnell* (T-AGOS 51). These upgrades, designed and developed by NRaD, included: (1) a new broadband acoustic Doppler current profile that separates, processes, time correlates, and refines analog sonar echoes to produce accurate ship's fore-aft, athwartship, and vertical velocity data for use by the survey system; and (2) integration of a sound velocity system that measures speed of sound in water at the ship's keel.

## OCEAN ENGINEERING

**Advanced Unmanned Search System (AUSS).** Delivered AUSS to the Navy Supervisor of Salvage (NAVSEA OOC).

**Air-Mobile Ground Security and Surveillance System (AMGSSS).** Designed, built, and demonstrated a Mission Payload Prototype (MPP). The MPP has all the prototype sensors—normal visual, infrared, acoustic

and laser rangefinder—as is currently envisioned for incorporation into the air mobile platform. An easy-to-use, Windows control display operator's interface was developed and implemented on a laptop computer. The system has been demonstrated with hand-held and larger SINCARS tactical radios as well as commercial radio frequency (RF) modems. The MPP represents a unique development with subsystems and radios communicating over Ethernet using TCP/IP. This implementation has allowed for distributed systems development and operation and offers the potential of modular, distributed surveillance systems operating with Ethernet or Internet connectivity.

**Mine Neutralization System (MNS).** Investigated Handling System problems related to the Mine Hunter, Coastal (MHC) class of minesweepers; assisted with MHC-unique design requirements and production problems; designed/fabricated/tested and installed improved MNV and SSA components and wrote and submitted Mission Package Depot Plan; supported design improvements and MPC testing; generated SSA launch and recovery procedures for MHC-unique problems related to MPC; supported two test sessions aboard ship to aid analysis and plans for improving the systems.

**Mobile Detection, Assessment, and Response System (MDARS).** Installed an MDARS interior robot in an office environment; continued evaluations with an installation in a warehouse environment. The MDARS exterior platform was operated successfully in a teleoperation mode. For the exterior program, the sensors, intrusion detection, and collision avoidance systems were demonstrated in a stand-alone mode. A new version of the MHIRA software was released and software conversion to the Windows NT operating system and Ada programming language was initiated.

## MARINE MAMMAL SYSTEMS (MMS)

**Marine Mammal Systems (MMS).** Developed and introduced into the Fleet a Shipboard Forward Deployment capability so that MMS can be transported, housed, and worked internal to the Task Force (from ship); upgraded fleet MMS with GPS to eliminate need for land-based naviga-

tion; enhanced capabilities of fleet MMS for shallow water (SW)/very-shallow water (VSW) mine countermeasures (MCM); turned over additional trained animals to all MMS; made first measurements of effect of depth/pressure on marine mammal hearing and sonar; provided highest quality veterinarian care to all Navy marine mammals; and Navy Marine Mammal Program and facilities were accredited by the American Association for the Accreditation of Laboratory Animal Care (AAALAC).

## INTEGRATION OF SPACE COMMUNICATION AND SURVEILLANCE SYSTEMS

**Multimission Advanced Tactical Terminal (MATT).** Delivery of production MATT is in progress. MATT can be used by all branches of the military as a tactical intelligence terminal, allowing space- and weight-constrained tactical platforms access to a wide range of intelligence products. MATT significantly downsizes current tactical receive equipment and adds additional radio channels. MATT can receive Tactical Data Dissemination System, Tactical Data Information Exchange Subsystem Broadcast (TADIXS-B), and Tactical Information Broadcast Service (TIBS), and considerable capacity remains for future growth.

**TRE Manager (TREM) and TRE Access Kernel (TREAK).** Completed test and evaluation of a graphical user interface to allow remote control of TRE v10.0 by software in a tactical data processor. The TREM uses TREAK to provide the communication interface to the TRE device. The "drop-in" module is transportable across both SUN and Hewlett-Packard platforms.

## ELECTRONIC SCIENCES AND TECHNOLOGY

**Analog Photonic Link Dynamic Range.** Demonstrated (with UCSD and Fermionics Corporation) the highest analog photonic link dynamic range ever reported using a single optical modulator. The link uses semi-

conductor electro-absorption modulators developed under ONR support and offers a simple and superior approach for shipboard antenna link designs requiring high dynamic range.

**D5 (Trident II) Missile Test and Readiness Equipment (MTRE).** Successfully completed Phase 3A Interface Testing of the MTRE Mk10 applications software including tactical launch and missile test. The test configuration included an actual Fire Control System, Guidance and Flight Control modules, MTRE Mk10, and the NRaD Missile simulator.

**Infrared Focal Plane Array (IRFPA).** Completed measurements on several state-of-the-art focal plane arrays: 64X64 quantum well focal plane from Martin-Marietta for the U.S. Air Force; 128X128 Mercury-Cadmium-Telluride from Santa Barbara Research for the U.S. Army Pilotline Experiment Technology (PET) program. Optical characterization of diamond windows/substrates for U.S. Army Exoatmospheric Kill Vehicle (EKV) program. LWIR in-band and out-of-band radiometric characterization of NASA AIRS filters. Radiometric and radiation effect characterization of three filters for the NASA LANDSAT-Thematic Mapper program.

**Low-Power Electronics (LPE).** Selected by Defense Advanced Research Projects Agency (DARPA) to be the agent for the Advanced Materials and Device Processing portion of the new LPE program. This program is run jointly by two offices at DARPA, the Microelectronics Technology Office and the Electronics Systems Technology Office. NRaD was chosen because of previous strong contractual support and its in-house fabrication facilities for semiconductor research and device development.

**Memory Chip.** Demonstrated excellent results for the 1K ferroelectric nonvolatile memory chips fabricated for the Strategic Systems Project Office. First-pass yield can be expected from the memory devices. Because of robust SPICE parameters and a mature, well-controlled process, two new circuits fabricated in ultra-thin silicon-on-sapphire in the last year have shown first-pass yield. Battery Ashburn is currently the only source in the U.S. that has the capability to quickly deliver fully depleted silicon-on-insulator circuits.

**Polarization-Independent Narrow-Channel (PINC) Wavelength Division Multiplexing (WDM).** Experimentally confirmed theory of wavelength response tuning of PINC WDM fiber couplers. The theory is based on effecting an index of refraction change in the coupler fused-glass region by irradiating it with intense UV light from a krypton fluoride excimer laser. The resulting change in index shifts the wavelength dependent coupling function of the PINC WDM, thus "tuning" it to match the specified channel wavelengths of a WDM optical fiber system. This tuning is controllable by varying the UV laser intensity or exposure time.

**Silicon-on-Sapphire (SOS).** Characterized deep sub-micron n- and p-channel transistors fabricated in 500 angstroms of SOS. These devices were shown to have useful gain at frequencies in excess of 50 GHz, comparable to the fastest silicon devices previously reported in the literature. At 2 GHz, a frequency used in personal, hand-held communications, the power gain was measured to be almost 20 dB.

**Silicon-on-Sapphire (SOS) Technology.** Completed a Cooperative Research and Development Agreement (CRADA) to assist in the technology transfer of NRad's SOS technology to develop active-matrix liquid crystal displays. The goal is to commercialize a pending NRad patent and subsequently produce low-cost projection displays that can be used by the Fleet in future commercial off-the-shelf (COTS) upgrades to the AEGIS command centers and the Advanced Combat Direction System (ACDS).

**Stochastic Resonance (SR).** Developed information-theoretic generalization of SR for aperiodic signals and application to simple neural model; demonstrated SR effect in signal detection statistics (detection probability, false-alarm probability) of nonlinear dynamic sensors; developed theory of Array Enhanced SR and noise-induced spatiotemporal synchronization in large arrays of nonlinear elements driven by periodic external signals; received invitation to write review article for *Physics Today*, to appear with cover feature in March 1996 issue; successfully demonstrated SR, including new (externally controlled) optimization scheme in laboratory SQUID sensor (phase 1 SBIR with Quan-

tum Magnetics, Inc.). Phase 2 Small Business Independent Research (SBIR) awarded for development of fully optimized high-Tc SQUID and design of prototype SQUID array using SR.

**Trident Stellar Sensor.** Developed an entirely new fabrication process to fabricate the charge-coupled device optical sensor used in the Trident guidance system. This process is a transition to all-ion implantation as opposed to the older process of doping by diffusion and thermal annealing. All-ion implantation simplifies the processing by eliminating several steps required in the diffusive method. Fluorine is being investigated as a possible dopant to improve the radiation hardness of the final device. Ion implantation, as a processing method, provides greater control and greater precision in the doping profiles and concentrations, especially at interfaces where these factors can be critical. Yield on the most recent lot averaged 84 percent. An improvement in dark current with the incorporation of fluorine was also seen.

**Tri-Service Support.** Hosted Tri-Service Generalized Emulation Microcircuit (GEM) Program review. Provided GEM technical interface to Air Force (Warner Robins Air Logistics Center [F-15], Hanscom AFB [JSTARS]); Navy (Aviation Supply Office, NAVAIR S-3); Army (Redstone Arsenal); NASA/Rockwell Space Systems Division (Space Shuttle); and Defense Electronic Supply Center. Directed contract effort to develop new emulation capability for nonprocureable, high-speed, and high-voltage microcircuits. Provided technical definition for GEM Production Program and next-generation microcircuit emulation. Reverse-engineered circa 1985 Hewlett Packard 7907-60095 hard disk controller card for Avionics Test Set Vi (ATS-Vi).

## ENVIRONMENTAL ASSESSMENT

**Butyltin Sample Study.** Completed report on "Butyltin Concentrations in Water Samples Collected during USS *Leffwich* Antifouling Point Removal Operations at Pearl Harbor Naval Shipyard—June 1994 through January 1995" for Pearl Harbor Naval Shipyard.

**Ecological Risk Assessment.** Completed Draft Final Estuarine Ecological Risk Assessment for Portsmouth Naval Shipyard in partial fulfill-

ment of NAVSHIPYD PORTSMOUTH's Response Conservation Recovery Act (RCRA) Corrective Measures Permit and Comprehensive Environmental Response Compensation and Liability Act (CERCLA) requirements.

**Integrated Naval Shipyard Compliance Project.** Provided NAVSEA with a draft report on the current status of compliance of naval shipyards and made short-term and long-term recommendations for an integrated approach to compliance for the shipyards.

**San Diego Bay Sediment Risk Assessment.** Performed extensive biological and chemical testing to study environmental effects from long-term naval operations and hazardous waste sites in San Diego Bay. Contaminant dispersion modeling is in progress.

**SINKEX.** Provided support to NAVSEA to conduct an ecological risk assessment to determine the potential hazards posed to the marine environment from at-sea disposal of Navy ships. Efforts are underway to locate a sunken naval hulk in the Southern California Operations area in 4000 to 6000 feet of water that can be used as a target vessel for sampling.

**Site Characterization and Analysis Penetrometer System (SCAPS).** Signed Cooperative Research and Development Agreement (CRADA) with Loral Corporation for commercialization and integration of SCAPS with Rapid Optical Scanning Tool (ROST). Accepted by Environmental Protection Agency (EPA) Environmental Monitoring Systems Laboratory, Las Vegas, NV, as the first program for Technology Verification under the EPA Consortium Program. NRaD, on behalf of the Department of Defense (DoD) Tri-Services, combined this program effort with similar programs already initiated with western governors and the California EPA. A formal demonstration of the LIF technology was successfully conducted at the Hydrocarbon National Test Site, Port Hueneme, CA (Spring 1995) and at Sandia National Laboratories, Albuquerque, NM (Fall 1995). Delivered EDM-2 and EDM-3 to Naval Facilities Engineering Support Center (NFESC). Both systems are fully active, conducting subsurface field screening of POL contamination at designated Navy activities. Deployed EDM-1 (home-based at NRaD) to conduct subsurface field screening of POL contamination at Navy Training Center, San

Diego, CA; Navy Outlying Landing Field, Imperial Beach, CA; Engine Test Cell, Point Mugu, CA; and Naval Air Station, San Diego, CA. EDM-1 also conducted field testing of a Raman Laser at Naval Air Station, San Diego, CA. Selected by the California EPA, (EPA is lead agency for the Interstate Technology and Regulator Cooperation Committee) for fast-track reciprocal acceptance of our pending Cal EPA Technology Certification. In addition to the 13 western states, New Jersey, Massachusetts, and Illinois have signed Memorandums of Understanding for the effort.

**Uniform National Discharge Standards.** Provided POA&M to NAVSEA to support technical data collection in support of uniform standard approach to environmental regulations relating to USN vessel discharges in various ports.

**Waterside Security System (WSS).** Completed WSS installation at NAVSUBASE Bangor with installation of (1) thermal imaging sensors (TIS) and (2) Swimmer Detection Sonar (SDS). The SDS remains in a test status until equipment software can be further modified to preclude generation of excessive false tracks.

## **FLEET SUPPORT AND IN-SERVICE ENGINEERING**

**Air Force JTIDS Interface Box.** Initiated transfer transition for project management.

**Command Center Network Phase II (CCN2).** Initiated request for frequency allocation for El Centro Intrusion Security System; completed drawing package review and microwave upgrade (phase I) at PMRF, HI; released completed test and evaluation plan and site acceptance test.

**Data Link Communications System (DLCS).** Completed Temporary Alteration (TEMPALT) Technical Development Plan (TDP) for installation of CP-2205/USQ-125 data terminal onboard SSN 688 class submarine; completed several dock site and seaside CSICs for SSN 688 submarines.



**Fleet Hospital Communications Van.** Successfully participated in Operation KB-95 at Camp Pendleton, resulting in additional FY 95 and FY 96 funding for development of replacement van.

**Integrated Submarine Automated Broadcast Processing System (ISABPS).** Successfully completed nine upgrades to systems deployed worldwide to Revision F, which provides a modern, supportable system to support fixed VLF broadcast; completed relocation of Naval Security Group Activity (NSGA), Adak, ISABPS suite to CSG-9, including conversion to latest configuration, without broadcast downtime.

**Integrated Voice Control Systems (IVCS).** Completed technical assistance aboard USS *New Orleans* (LPH 11) and USS *Jumeau* (LPD 10) in Persian Gulf.

**JTIDS/Link-16 In-Service Support:** Established JTIDS Technical Configuration Review Board; served as lead Navy technical support activity for resolution of key fleet JTIDS technical problems; assumed all JTIDS tasks from the Program Executive Office (PEO); established Link-16 Fleet Support Laboratory; began development of Link-16 Interactive Electronic Technical Manual; supported all Link-16 equipped Battle Groups with ship riders.

**JTIDS/Link-16 Project Office (LPO).** Established and chaired JTIDS Trouble Report Review Board; assumed JTIDS Cryptographic Controlling Authority responsibility; maintained JTIDS Reliability Data Base; provided training, documentation and spares assistance in support of over 30 Link-16 ship installations.

**Mobile In-shore Undersea Warfare (MIUW).** Completed integration, testing, and system certification of the first set of Mobile Integrated Command Facility (MICFAC) vans and auxiliary equipment; successfully demonstrated MICFAC in Joint Warfare Exercise; MICFAC will be shipped to Middle-East Naval Force Commander.

**NATO Interoperable Submarine Broadcast System (NISBS).** Completed platform compatibility testing of software version 3.2.

**SATCOM-SHF/EHF/UHF, AUTO/TACTICAL IXS.** Completed numerous EHF, SHF, UHF, INMARSAT installations aboard ships; began installations (eight) of EHF communications controller aboard USS *Enterprise* Battle Group; participated in SATCOM IPTs.

**Shipboard Communications.** Achieved Common User Digital Information Exchange System II (CUDIXS II) Full Operational Capability (FOC) and successfully completed software upgrade 10.0.

**Special Communications (SPECOMM).** Completed system deinstallation at NSGA, Adak, and installation at Remote Site 3; completed onsite maintenance at Remote Sites 1 and 2; completed system relocation and Site Operational Validation Test (SOVT) of Remote Site 2; completed Base Electronic System Engineering Plan (BESEP) for relocation at NCTSI, Keflavik, Iceland.

**Submarine LF/VLF VME Receiver (SLVR).** Completed preliminary implementation plan; completed and submitted installation and design reservation data to address equipment weight, space, and power requirements; participated in Engineering Technical Review.

**Tactical Data Information Exchange System (TADIXS).** Reinstalled Phase 3 at five Pacific activities/commands; developed BESEP for installation and installed Phase 3 at NCTSI, San Diego.

**Tactical Intelligence (TACINTEL).** Completed design, test, and integration of TACINTEL II+ system equipment, and developed technical manual and interim Preventive Maintenance System (PMS); successfully demonstrated AN/USQ-124(V)3 TACINTEL II+ aboard USS *Coronado* (AGF 11); completed TACINTEL II+ installations on 33 ships; installed and tested CSS IP routers in the Pacific Area.

**Time and Frequency Distribution System (TFDS).** Developed new concept based on coupling cesium, rubidium, and GPS technologies into one modular system reconfigurable for diverse application to be deployed in the surface, subsurface, shore, and airborne environment; completed program marketing survey, procurement specifications, test and evaluation plans and procedures, and SSN 688 Land-Based Submarine Radio Room integration plans and drawings.



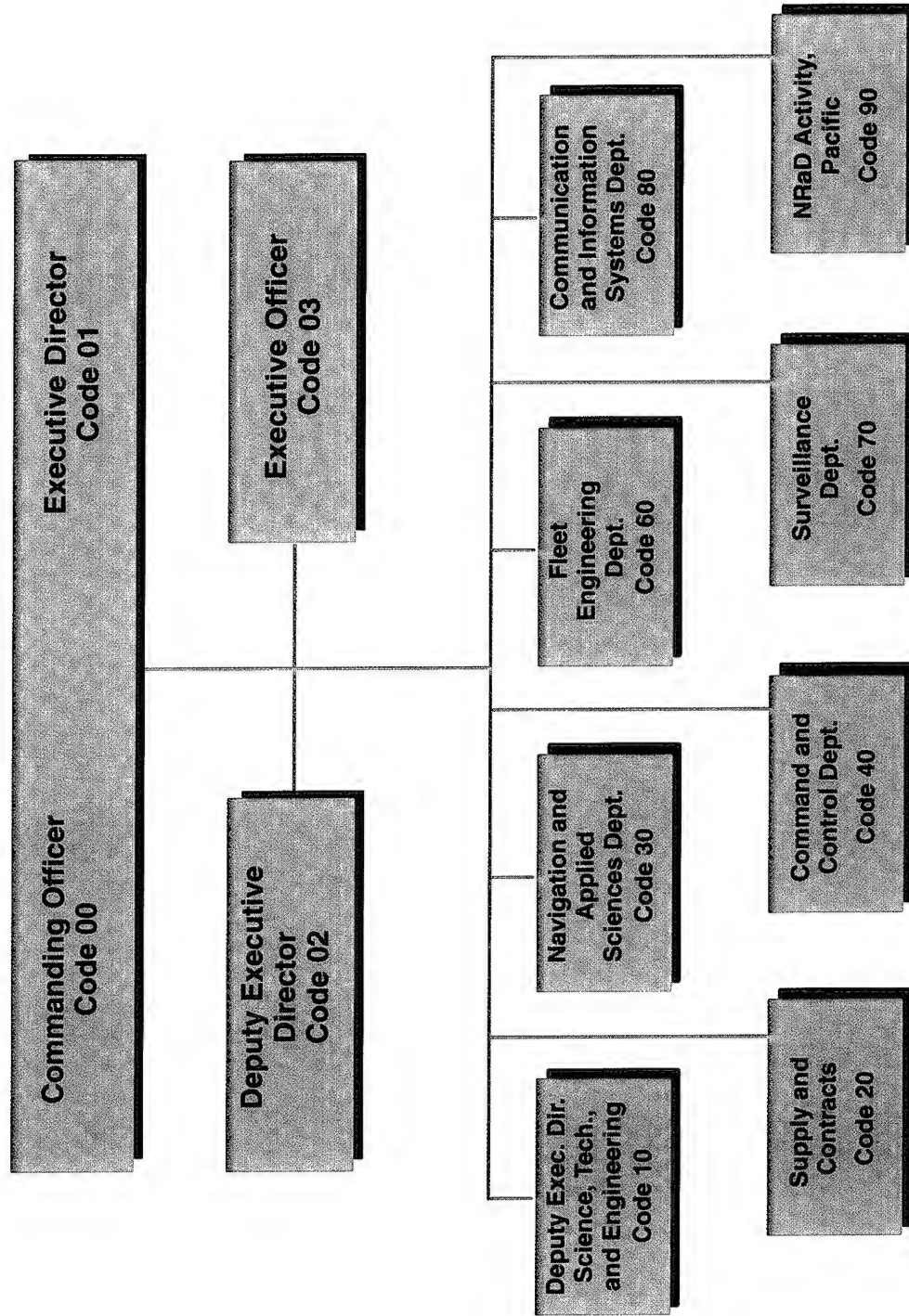
**USAID VSAT Network.** Installed 40 VSAT terminals worldwide; tasked General Services Administration (GSA) to set up satellite network.

**VERDIN.** Completed platform compatibility testing of Enhanced VERDIN system software 7.6, which provides Automatic Mode Recognition (AMR) for HIDAR transmissions of Emergency Action Messages (EAMs); initiated fleet deployment to all SSBNs, SSNs, submarine tenders, VLF Shore Monitor and broadcast sites, submarine schools, and TACAMO aircraft; upgraded over 100 systems; completed 12 Enhanced VERDIN System (EVS), SHIPALT 3861D installations on SSN 688 submarines.

## INDEPENDENT RESEARCH (IR)

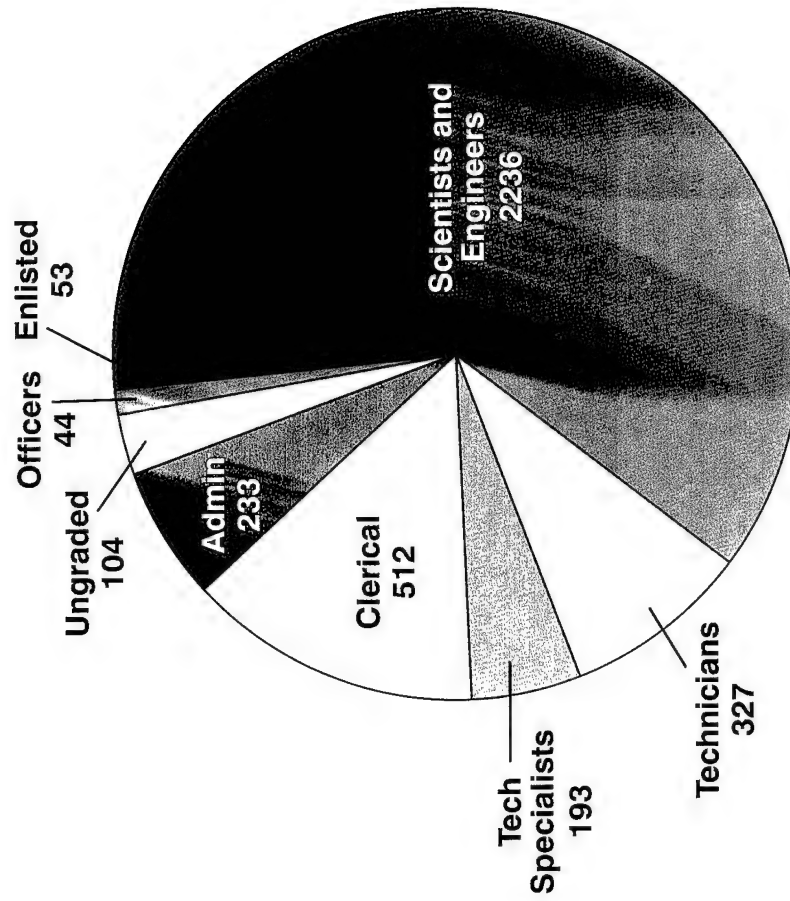
**Independent Research Program.** The NRaD FY 95 IR program consisted of 29 projects totaling \$2463K. Significant accomplishments included (1) theoretical and experimental demonstrations of enhanced diffusivity in San Diego Bay; (2) derivation of algorithms suitable for blind equalization of M-ary quadrature amplitude modulation (QAM) in complex communications channels; (3) an explicit analytic solution for the behavior of a combined adaptive spatio-temporal communications receiver; and (4) demonstration of a wide-dynamic range, efficient mixer using photonic techniques that operate well into the tens-of-gigahertz range.

## NCCOSC RDT&E DIVISION ORGANIZATION



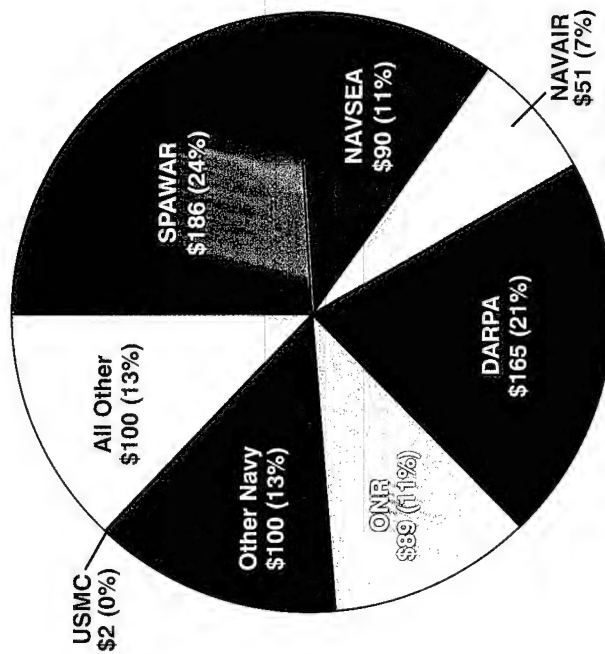
PERSONNEL DATA

**NRaD PERSONNEL  
31 DECEMBER 1995  
(TOTAL 3702)**

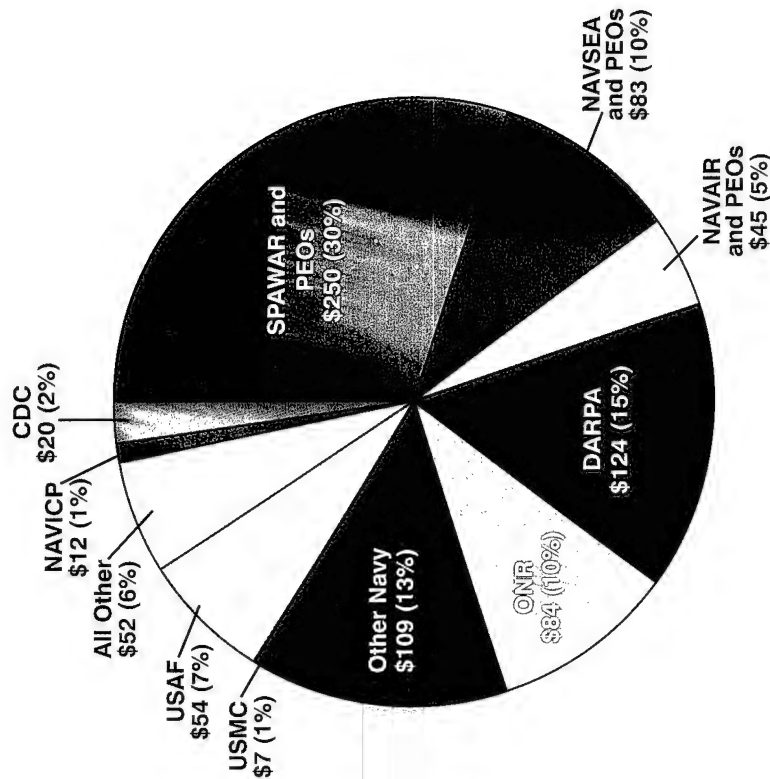


# FUNDING BY SPONSOR

FUNDING BY SPONSOR FY 1995  
(ACTUAL \$783 MILLION)



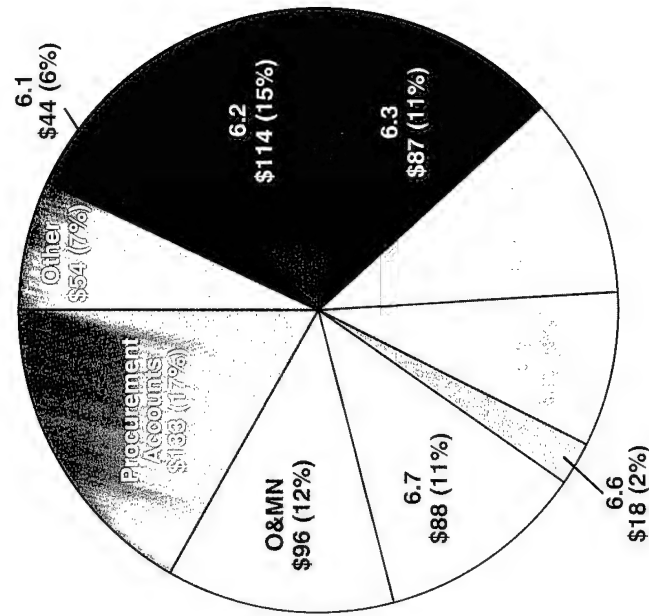
FUNDING BY SPONSOR FY 1996  
(BUDGETED \$840 MILLION)



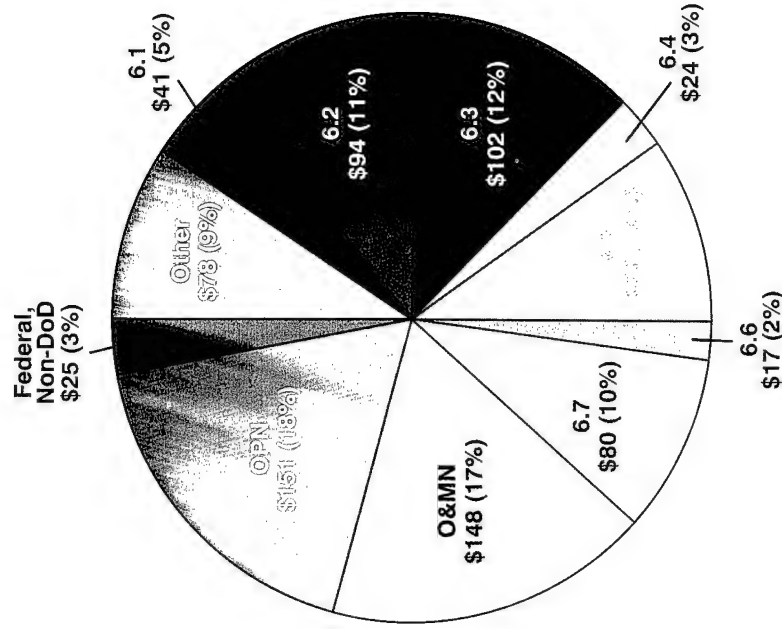
- Centers for Disease Control
- Defense Advanced Research Projects Agency
- Naval Air Systems Command
- Navy Inventory Control Point
- Naval Sea Systems Command
- Office of Naval Research
- Space and Naval Warfare Systems Command
- United States Air Force
- United States Marine Corps

## FUNDING BY APPROPRIATION

FUNDING BY APPROPRIATION, FY 1995  
(ACTUAL \$783 MILLION  
INCLUDES DIRECT CITES \$265 MILLION)

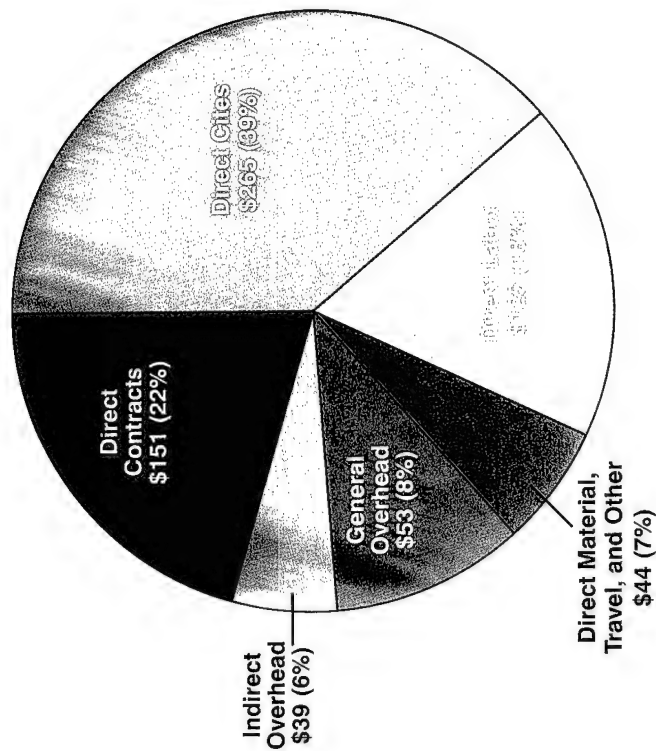


FUNDING BY APPROPRIATION, FY 1996  
(BUDGETED \$840 MILLION  
INCLUDES DIRECT CITES \$253 MILLION)

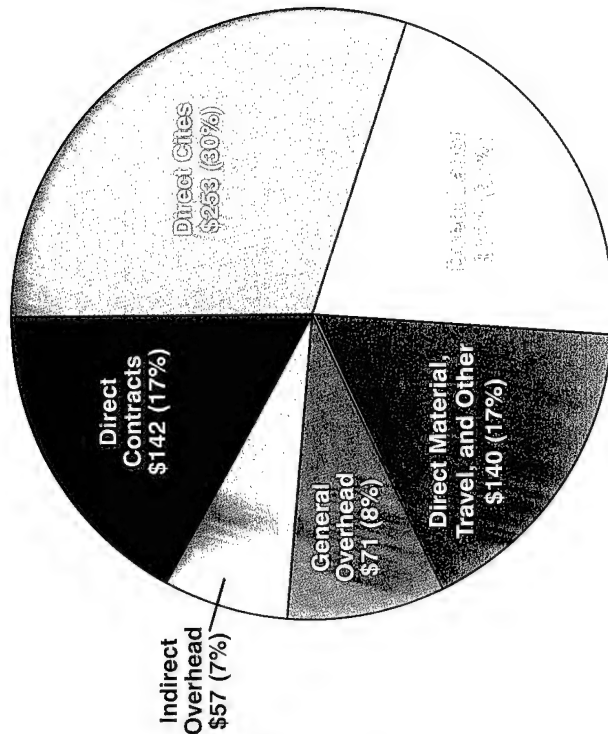


# DISTRIBUTION OF FUNDS

DISTRIBUTION OF FUNDS, FY 1995  
(ACTUAL \$677 MILLION)



DISTRIBUTION OF FUNDS, FY 1996  
(BUDGETED \$840 MILLION)





# ABBREVIATIONS AND ACRONYMS

AAALAC	American Association for the Accreditation of Laboratory Animal Care	ATD	Advanced Technology Demonstration
ACDS	Advanced Combat Direction System	ATDS	Airborne Tactical Data System
ACDS Block 0	Advanced Combat Direction System Block 0	ATE	Automatic Test Equipment
ACDS Block 1	Advanced Combat Direction System Block 1	ATS-Vi	Avionics Test Set Vi
ACMS	Automated Communications Management System	ATM	Asynchronous Transfer Mode
ACU	Antenna Control Unit	ATV	Advanced Tethered Vehicle
ADNS	Automated Digital Network System	AUSS	Advanced Unmanned Search System
ADS	Advanced Deployable System	AUTODIN	Automated Digital Information Network
AEGIS	Airborne Early Warning/Ground Integration Segment	AUV	Autonomous Undersea Vehicle
AFMSS	Air Force Mission Support System	AWACS	Aircraft Warning and Control System
AFSATCOM	Air Force Satellite Communications	BBS	Baseband Switch
AFWTF	Atlantic Fleet Weapons Test Facility	BESEP	Base Electronic System Engineering Plan
AFWTF	Atlantic Fleet Weapons Training Facility	BG	Battle Group
AIC	Atlantic Intelligence Command	BGPHERS	Battle Group Passive Horizon Extension System
AIU	Advanced Interface Unit	BLAC	Bottom Limited Active Classification
ALE	Automatic Link Establishment	BLOS	Beyond Line of Sight
ALSP	Aggregate Level Simulation Protocol	BMD	Ballistic Missile Defense
AMGSSS	Air-Mobile Ground Security and Surveillance System	BMDO	Ballistic Missile Defense Organization
AMR	Automatic Mode Recognition	C <sup>2</sup>	Command and Control
ANCRS	Automated Navy COMSEC Reporting System	C <sup>2</sup> P	Command and Control Processor
ANDVT	Advanced Narrowband Digital Voice Terminal	C <sup>3</sup> I	Command, Control, Communications, and Intelligence
AODS	All Optical Deployment System	C <sup>4</sup> I	Command, Control, Communications, Computers, and Intelligence
APC	Advance Planning Cell	C <sup>4</sup> ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
APL	Applied Physics Laboratory		
ASAP	Advanced Sensor Applications Program		
ASROC	Antisubmarine Rocket		
ASTECS	Advanced Submarine Tactical ESM Combat System	CAMBR	Common Aperture Multi-Band Radar
		CAPS	Coordinated Adaptive Planning System
ASW	Antisubmarine Warfare	CARIBROC	Caribbean Regional Operations Center

# ABBREVIATIONS AND ACRONYMS

CAT	CSS/JMCIS Action Team	CORBA	Common Object Request Broker Architecture
CATS	Crisis (Combat) Action Teams	COTS	Commercial Off-The-Shelf
CCN2	Command Center Network Phase II	CQ	Carrier Qualification
CCSC	Cryptologic Combat Support Console	CRADA	Cooperative Research and Development Agreement
CDBS	Central Data Base Server	CSACF	Combat Systems Assembly and Checkout Facility
CDES	CDS Development and Evaluation Site	CSIC	Combat System Interoperability Certification
CDNU	Control Display Navigation Unit	CSIT	Combat Systems Integration Test
CDS	Combat Direction System	CSRR	Combat Systems Readiness Review
CEA	Central Engineering Activity	CSS	Communications Support System
CEC	Cooperative Engagement Capability	CTAPS	Contingency Theater Automated Planning System
CERCLA	Comprehensive Environmental Response Compensation and Liability Act	CTP	Common Tactical Picture
CFA	Cognizant Field Activity	CUB	Cryptologic Unified Build
CIO	Central Imagery Office	CUDIXS II	Common User Digital Information Exchange System II
CIS	Combat Intelligence System		
CIU	Communications Interface Unit		
CJCS	Commander Joint Chiefs of Staff		
CJTF	Combined Joint Task Forces	DADS	Deployable Autonomous Distributed Systems
CLMC	Closed Liquid Metal Combustion	DAMA	Demand-Assigned Multiple-Access
CLR	Coherent Laser Radar	DARPA	Defense Advanced Research Projects Agency
CMSA	Cruise Missile Support Activity	DASC	Direct Air Support Central
CMSAS	CIRCUIT MAYFLOWER Shore Automation System	DCS	Defense Communication System
CNC	Communications Node Controller	DCT	Developmental Certification Test
COIs	Critical Operational Issues	DCT-001	Developmental Certification Test 001
COMINT	Communications Intelligence	DF	Direction Finder
COMOPTEVFOR	Commander, Operational Test and Evaluation Force	DII	Defense Information Infrastructure
COMPASS	Common Operational Modeling, Planning, and Simulation Strategy	DII COE	Defense Information Infrastructure Common Operating Environment
COMSEC	Communications Security	DIS	Distributed Interactive Simulation
COMSUBLANT	Commander, Submarine Force, Atlantic Fleet	DISA	Defense Information Systems Agency
COMUSNAVCENT	Commander, United States Naval Center	DLCS	Data Link Communications System
COMEX	Communications Exercise	DMA	Defense Mapping Agency
CONOPS	Concept of Operations	DMSP	Defense Meteorological Satellite Program
		DoD	Department of Defense

# ABBREVIATIONS AND ACRONYMS

DPL	Digital Photo Lab	FMOCC	Fleet Mobile Operational Command Center
DREA	Defence Research Establishment Atlantic	FMS	Foreign Military Sales
DSI	Defense Simulation Internet	FOC	Full Operational Capability
DSVC	Dam Neck Systems Validation Center	FOG	Fiber-Optic Gyro
DSVL	Doppler Sonar Velocity Log	FPI	Functional Process Improvement
DTD	Data Terminal Device	FVLF	Fixed Very-Low-Frequency
DT/OT	Developmental Test/Operational Test		
EAM	Emergency Action Message	GAT	Government Acceptance Test
EAP	Emergency Action Procedure	GBS	Global Broadcast System
ECPs	Engineering Change Proposals	GCB	General Communications Backbone
EDAC	Error Detection and Correction	GCCS	Global Command and Control System
EDM	Engineering Development Model	GEM	Generalized Emulation Microcircuit
EGI	Embedded GPS Inertial	GFAT	Government Factory Acceptance Testing
EIP	Embedded INFOSEC Product	GGP	GPS Guidance Package
EKMS	Electronic Key Management System	GINA	GPS Inertial Navigation Assembly
EKV	Exoatmospheric Kill Vehicle	GOFR	Geolocations of Radio Frequency Interference
ELINT	Electronics Intelligence	GOTS	Government Off-The-Shelf
EMC	Electromagnetic Compatibility	GPS	Global Positioning System
EMF	Electromagnetic Field	GSA	General Services Administration
EMI	Electromagnetic Interference	GSF	Gaming and Simulation Facility
EOB	Electronic Order of Battle	GUI	Graphical User Interface
EPL	Electronic Parameters List		
ESM	Electronic Support Measures	HARM	High-Speed Anti-Radiation Missile
EVS	Enhanced VERDIN System	HCI	Human-Computer Interface
EW	Electronic Warfare	HDR	High-Data-Rate
		HFSWR	High-Frequency Surface Wave Radar
FAA	Federal Aviation Administration	HIDAR	High Data Rate (an SCS communications mode)
FCC	Fleet Command Center	HLA	Horizontal Line Array
FCIP	Field Change Installation Program	HMI	Human-Machine Interface
FCTCLANT	Fleet Combat Training Center, Atlantic	HMM	Hidden Markov Model
FCTCPAC	Fleet Combat Training Center, Pacific	HPC	High-Performance Computing
FDS	Fixed Distributed System	HPI	High-Probability-of-Intercept
FEWSG	Fleet Electronic Warfare Support Group	HSDS	High-Speed Data Switch
FMA	Fleet Maintenance Agent	HYCOOP	Hydrographic Cooperative Program

# ABBREVIATIONS AND ACRONYMS

HyDy	Highly Dynamic	IVTT	Integrated VERDIN Transmit Terminal
IC	Integrated Circuit	IXS	Information Exchange System
IC	Interior Communications	JDEF	Joint Demonstration and Evaluation Facility
ICS	Integrated Communications Subsystem	JDISS	Joint Defense Intelligence Support Services
IDB	Integrated Data Base	JFACC	Joint Forces Air Component Commander
IFF	Identification, Friend or Foe	JICPAC	Joint Intelligence Center, Pacific
ILS	Integrated Logistics Support	JITCs	Joint Interoperability Test Command's
INFAC	Inertial Test Facility	JMCIS	Joint Maritime Command Information System
INFOSEC	Information Security	JMCOMS	Joint Maritime Communications Strategy
INM	Integrated Network Manager	JMO	Joint Maritime Operations
INMARSAT	International Maritime Satellite Organisation	JSIPS-N	Joint Service Imagery Processing System-Navy
INSURV	Inspection and Survey	JSTARS	Joint Surveillance Target Attack Radar System
IOC	Initial Operational Capability	JTFEX	Joint Task Forces Exercise
IP	Internet Protocol	JTIDS	Joint Tactical Information Distribution System
IPT	Integrated Product Team	JWICS	Joint Worldwide Intelligence Communications System
IR	Independent Research	JWID	Joint Warrior Interoperability Demonstration
IRFPA	Infrared Focal Plane Array	KB95	Kernel Blitz 95
IRR	Integrated Radio Room	KMS	Key Management System
IRS	Interface Requirements Specification	LAMPS	Light Airborne Multi-Purpose System
ISABPS	Integrated Submarine Automated Broadcast Processing System	LAN	Local-Area Network
ISAR	Inverse Synthetic Aperture Radar	LBSRR	Land-Based Submarine Radio Room
ISE	In-Service Engineering	LBTF	Land-Based Test Facility
ISEA	In-Service Engineering Agent	LDAR	Light Detection And Ranging
ISEF	IUSS System Engineering Facility	LEO	Low Earth Orbit
ISR	Intelligence, Surveillance, and Reconnaissance	LFA	Low-Frequency Active
ISSF	Interim Supply Support Facility	LLSS	Low-Light Serial Switch
ISTEF	Innovative Science and Technology Experimentation Facility	LMS	Least Mean Square
ITMS	Information Transfer Management Structure	LOCC	Local Operations Control Center
IUSS	Integrated Undersea Surveillance System	LOS	Line of Sight
IV&V	Independent Verification and Validation	LPE	Low-Power Electronics
IVCS	Integrated Voice Control Systems		

LPO	Link-16 Project Office	MLTS	Multi-Link Transmit Simulator
LRIP	Low Rate Initial Production	MMATS	Marine Mammal Acoustic Tracking System
LTS	Low-Frequency-Active Transmit Subsystems	MMPS	MILSTAR Message Processing System
LWIR	Long-Wave Infrared	MMRT	Modified Miniature Receive Terminal
M&S	Modeling and Simulation	MMS	Marine Mammal Systems
MAGTF	Marine Air Ground Task Force	MNS	Mine Neutralization System
MAST	Mobile Ashore Support Terminal	MNV	Mine Neutralization Vehicle
MATCALS	Marine Air Traffic Control and Landing System	MODSAF	Modular Semi-Automated Forces
MATT	Multimission Advanced Tactical Terminal	MONET	Mobile Internet
MCM	Mine Countermeasures	MOS	Metal Oxide Semiconductor
MCM	Multi-Chip Module	MOSC	Modeling and Simulation Operation Support Cell
MCS	Mission Computer System	MPC	Multipurpose Crane
MDARS	Mobile Detection, Assessment, and Response System	MPI	Max Planck Institutes (Potsdam, Germany)
MEF	Marine Expeditionary Force	MPL	Marine Physical Laboratory
MERS	Multifunction Electromagnetic Radiating System	MPP	Mission Payload Prototype
MerWatch	Merchant Watch	MRTDF	Multiple ROTH R Track Data Fusion
MESO	Marine Environmental Support Office	MSC	Military Sealift Command
METOC	Meteorological and Oceanographic	MSP	Mobile Sensor Platform
MHC	Mine Hunter, Coastal	MTRE	Missile Test and Readiness Equipment
MHRA	Multiple Host Robot Architecture	MTS	Man Transportable SOCRATES
MICFAC	Mobile Integrated Command Facility	MTWS	MAGTF Tactical Warfare Simulation
MIDS	Multifunctional Information Distribution System	NAASW	Non-Acoustic, Antisubmarine Warfare
MILCOM	Military Communications	NAOC	National Airborne Operations Center
MILNET	Military Network	NASA	National Aeronautics and Space Administration
MILSATCOM	Military Satellite Communications	NATO	North Atlantic Treaty Organization
MILSTAR	Military Strategic and Tactical Relay	NAVAIDS	Navigational Aids
MIMIC	Millimeter and Microwave Integrated Circuit	NAVAIR	Naval Air Systems Command
MIUW	Mobile In-shore Undersea Warfare	NAVSEA	Naval Sea Systems Command
MIUW-SU	Mobile In-shore Undersea Warfare-System Upgrade	NAVOCEANO	Naval Oceanographic Office
MLP	Multilayer Perceptron	NAVSSI	Navigation Sensor System Interface
MLS	Multilevel Security	NAWC-AD	Naval Air Warfare Center-Aircraft Division

## ABBREVIATIONS AND ACRONYMS

NCCOSC	Naval Command, Control and Ocean Surveillance Center	NUSTF	Navy UHF Satellite Communications Test Facility
NCCS-A	Navy Command and Control System-Ashore	NUWC	Naval Undersea Warfare Center
NCS	National Communication Systems	NVIS	Near Vertical Incidence Skywave
NCTSI	Navy Center for Tactical System Interoperability		
NDSC	Non-Acoustic Distributed Systems Components	OBU	OSIS Baseline Upgrade
NECC	Navy EHF Communications Controller	OED	OSIS Evolutionary Development
NESP	Navy EHF SATCOM Program	ONI	Office of Naval Intelligence
NFESC	Naval Facilities Engineering Support Center	ONR	Office of Naval Research
NISBS	NATO Interoperable Submarine Broadcast System	OPNAV	Office of the Chief of Naval Operations
		OPEVAL	Operational Evaluation
		OPTEVFOR	Operational Test and Evaluation Force
NISE West	NCCOSC's West Coast In-Service Engineering Division	OSD	Office of the Secretary of Defense
NKDS	Navy Key Distribution System	OSIS	Ocean Surveillance Information System
NMCC	National Military Command Center	OSO	Operational Support Office
NMITC	Navy Marine Corps Intelligence Training Center	OSP	Ocean Survey Program
		OSP SIL	Ocean Survey Program System Integration Laboratory
NN	Neural Net		
NOC	Network Operations Center	OSP/UK SIL	Ocean Survey Program and United Kingdom System Integration Laboratory
NONAP	Non-Linear Adaptive Processor	OSS	Operation Support System
NPS	Navigation Processing System	OTAR	Over-the-Air-Rekey
NRaD	NCCOSC RDT&E Division	OTG	Over-the-Horizon-T Gold (C <sub>2</sub> message format for machine readable data)
NRL	Naval Research Laboratory	OTH	Over-the-Horizon
NRT-EOB	Near-Real-Time Electronic Order of Battle	OTH-T	Over-the-Horizon Targeting
NSA	National Security Agency		
NSAT	Navy Site Acceptance Testing	P <sup>3</sup> I	Pre-planned Product Improvement
NSGA	Naval Security Group Activity	PACNORWEST	Pacific Northwest
NSWC	Naval Surface Warfare Center	PAT	Program Acceptance Test
NSWCDD	Naval Surface Warfare Center Dahlgren Division	PDEC	Processing and Data Exploitation Center
		PDS	Processing and Display System
NTCS-A	Navy Tactical Command System-Afloat	PDU	Peripheral Device Unit
NTDS	Naval Tactical Data System	PDU	Protocol Data Unit
NTIA	National Telecommunications Information Administration		



PENEX	Polar Equatorial Near-Vertical-Incidence Experiment	RNAS	Relative Navigation and Analytic Simulator
PEO	Program Executive Office	RNUS	Range NTDS Upgrade System
PET	Program Experiment Technology	ROK	Republic Of Korea
PINC	Polarization-Independent Narrow-Channel	ROST	Rapid Optical Scanning Tool
PIP	Phased Improvement Program	ROTHR	Relocatable Over-the-Horizon Radar
PITCO	Pre-Installation and CheckOut	RTF	Range Test Facility
PLRS	Position Location Reporting System	RTF	Radar Test Facility
PMRF	Pacific Missile Range Facility	RTHEPCF	Real-Time Embedded High-Performance Computing Facility
PMS	Preventive Maintenance System		
POA&M	Plan of Action and Milestones	SACLANT	Strategic Air Command, Atlantic
POC	Point of Contact	SAFENET	Survivable Adaptable Fiber-Optic Embedded Network
POL	Petroleum, Oil, Lubricant		
POWERR	Prototype Operational Workstation for EW/RFI Resolution	SAOTA	Surveillance All-Optical Towed Array
		SAR	Synthetic Aperture Radar
QAM	Quadrature Amplitude Modulation	SAT	System Acceptance Test
QPM	Quasi-Phase Matched	SATCOM	Satellite Communications
		SAOTA	Surveillance All-Optical Towed Array
RADIAC	Radioactive Detection Indication and Calibration	SBDS	Small Boat Deployment System
RCRA	Response Conservation Recovery Act	SBIR	Small Business Independent Research
RCS	Radar Cross Section	SCAPS	Site Characterization and Analysis Penetrometer System
RDT&E	Research, Development, Test and Evaluation	SCAT	Submarine Communications Assessment Tool
REDFIL	Reduced-Power Digital Filter	SCI	Secure Compartmented Information
RELNAV	Relative Navigation Analytic Simulator	SCORE	SIGINT Correlation of Recognized Emitters
REM	Range Extension Mode	SCORE	Southern California Offshore Range
RESA	Research, Evaluation, and Systems Analysis	SCORSBY	Simulated Ship's Motion Facility
RF	Radio Frequency	SCS	Strategic Connectivity System
RFI	Radio Frequency Interference	SCSS	Submarine Communications Support System
RIC	Radar Intercept Officer	SDCAD	Surveillance Data Collection and Distribution
RICS	Replacement ICS	SDS	Surveillance Direction System
RIT	Rapid Imagery Transmission	SDS	Swimmer Detection Sonar
RLBTS	Reconfigurable Land-Based Test Site	SFQIT	Software Formal Qualification Test Procedures
RLGN	Ring Laser Gyro Navigator	SIF	Systems Integration Facility

# ABBREVIATIONS AND ACRONYMS

SIGINT	Signals Intelligence	SSTS	Ship Service Telephone Systems
SIGSEC	Signals Security	STD/R	Stochastic Target Detection and Recognition
SIMNET	Simulator Network	STIC	Surveillance Test and Integration Center
SINGGARS	Single Channel Ground/Air Radio System	STOW	Synthetic Theater of War
SISL	Secure DSI Integration Simulation Laboratory	STOW-E	European Synthetic Theater of War
SLBM	Submerged Launch Ballistic Missile	STP	Space Test Program
SLEP	Service Life Extension Program	STR	Software Trouble Report
SLVR	Submarine LF/VLF VME Receiver	STRAP	Sonobuoy Thinned Random Array Program
SMB	Submarine Message Buffer	STRED 95	Standard TRE Display 95
SMIFTS	Specially Modulated Imaging Fourier Transform Spectrometer	SURF	SIGINT Universal Recognition Facility
SOCAL	Southern California	SURTASS	Surveillance Towed-Array Sensor System
SOCRATES	Special Operations Command Research Analysis and Threat Evaluation System	SW	Shallow Water
SOF-IV	Special Operations Forces Intelligence Vehicle	SWATH	Small-Waterplane-Area Twin Hull
SONET	Synchronous Optical Network	SWELLEX	Shallow-Water Environmental Cell Experiment
SOS	Silicon-on-Sapphire	SWIFT	Signals Warfare Integrated Facilities Testbed
SOSUS	Sound Surveillance System	SWSS	Shallow-Water Sensor System
SOVT	Site Operational Validation Test		
SPAWAR	Space and Naval Warfare Systems Command	T&E	Test and Evaluation
SPECOMM	Special Communications	TACAMO	Take Charge and Move Out
SPO	System Program Office	TACAN	Tactical Air Navigation
SQUID	Superconducting Quantum Interference Device	TACINTEL	Tactical Intelligence
		TACTS	Tactical Air Combat Training Systems
SR	Stochastic Resonance	TADIL	Tactical Data Link
SRAM	Systems Replacement and Modernization	TADIXS	Tactical Data Information Exchange System
SRS	Software Requirements Specification	TADIXS B	Tactical Data Information Exchange System Broadcast
SSA	Software Support Activity	TAFIM	Technical Architecture for Information Management
SSBN	Ballistic Missile Submarine, Nuclear Powered	TAMPS	Tactical Aircraft Mission Planning System
SSEE	Ship Signal Exploitation Equipment	TARIF	Tactical Air Range Instrumentation Facility
SSIT	Sub-System Integration Test	TBMD	Theater Ballistic Missile Defense
SSIXS	Submarine Satellite Information Exchange System	TDA	Technical Development Agent
SSPO	Strategic Systems Program Office	TDDS	TRAP Data Dissemination System
SSSA	System Software Support Activity	TDP	Technical Development Plan

# ABBREVIATIONS AND ACRONYMS

TEAL	Tactical Engineering Analysis Laboratory	TTS	Tomahawk Transmitting Systems
TECHEVAL	Technical Evaluation		
TEMPALT	Temporary Alteration	UAV	Unmanned Airborne Vehicle
TESS	Tactical Environment Support System	UCSD	University of California San Diego
TFDS	Time and Frequency Distribution System	UMVs	Unmanned Vehicles
ThAW	Theater Acoustic Warfare	URMTT	Universal Radar Moving Target Transponder
TIBS	Tactical Information Broadcast System	USA	United States Army
TIPRS	Tomahawk In-flight Position Reporting System	USAF	United States Air Force
TIS	Thermal Imaging Sensors	USAID	United States Agency for International Development
TMD	Theater Missile Defense	USMC	United States Marine Corps
TMPS	TACAMO Message Processing System	USN	United States Navy
TOT	TRAP Operator Terminal		
TRANSDEC	Transducer Evaluation Center	VERDIN	Very-Low-Frequency Digital Information Network
TRAP	Tactical Related Applications		
TRE	Tactical Receive Equipment	VLA	Vertical Launch ASROC
TRE/TRAP	Tactical Receive Equipment/TRE-Related Applications	VME	Virtual Memory Environment
TREAK	TRE Access Kernel	VSAT	Very Small Aperture Terminal
TREM	TRE Manager	VSW	Very Shallow Water
TRU	Tomahawk Receiver Unit	VTC	Video Teleconference
TSCM	Tomahawk Strike Coordination Module		
TSL	Tactical Surveillance Laboratory	WAL	Warfare Analysis Laboratory
TSSC	Tactical Systems Support Complex	WAN	Wide-Area Networks
TSTP	Total Ship Test Program	WDM	Wavelength Division Multiplexing
		WSS	Waterside Security System